

MARCH 1985 \$1.50

Popular Mechanics

COMPLETE
GUIDE:
The '85
Imports

MERKUR: Best
In PM's Sport
Sedan Test



NEW GEAR TO BATTLE TODAY'S DEADLY FIRES

PLANS: Build
Our Solid-Teak
English Garden
Furniture

MILLION-MILE REPORT

MERCEDES 190
Owners Ask:
Where's The
Power?

PLANS: 6 Easy-
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Accessories
Of Solid Pine

COMPUTERS
Make Your Own
Hookup Cables
For Modem
And Printer

WOODWORKING
10 Sturdy Leg-To-Rail
Joints For Furniture

Firefighters
Push into A
Blaze With
Heat-Seeking
Camera And
Mist Nozzles



03



754744

4x4xFord!

Only Ford gives you a choice of big and small 4x4 pickups with independent front suspension.

And for '85, Ford's high-output engines make their performance even more exciting.

Ford's responsive power gives you extra muscle off the road, extra pleasure wherever you drive. Strong reasons to choose the 4x4's that lead all others in total sales.*

New Ranger power.

For '85, Ranger has a new 2.3L 4-cylinder engine with electronic fuel injection, standard. Or, you can go with Ranger's 2.8L V-6



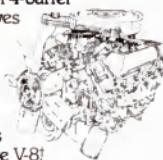
for power no other small V-6 pickup can top. Some choice!

More '85 news: 5-speed manual overdrive is now standard with all engines, new 4-speed automatic overdrive transmission optional with V-6.

Big F-Series power.

Ford's big 4x4's offer you a choice of five husky engines. Every one from standard 4.9L Six up leads its nearest competitor's in load-moving torque.

And the 5.8L High Output V-8 with 4-barrel carb gives you 45 more horse-power than Chevy's mid-size V-8!



Tough suspensions.

Both big and small 4x4's have Ford's exclusive Twin-Traction-Beam front suspension. Independent wheel action absorbs off-road jolts and helps keep wheels glued to the ground. Both give you Ford's proven 4-wheel-drive system with manual or optional automatic locking hubs.

Biggest pickup choice.

Pick short or long-bed Ranger. Or F-Series Regular Cab, exclusive SuperCab or 4-door Crew Cab—plus

payloads big as 4,485 lb. Nobody else does so much to meet your needs!

Best-Built American Trucks.

At Ford, Quality is job 1. A 1984 survey established that Ford makes the best-built American trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1983 models designed and built in the U.S.

Lifetime Service Guarantee.

As part of Ford Motor Company's commitment to your total satisfaction, participating Ford Dealers stand behind their work, in writing, with a Lifetime Service Guarantee. No other car companies' dealers, foreign or domestic, offer this kind of security. Nobody. See your participating Ford Dealer for details.

Dealer-installed Ranger light bar not for occupant safety.
*Based on new truck registrations thru August, 1984.

†Optional, not available in California or with manual transmission. Horsepower based on SAE Standard J1349.



"My Ford Pickup & Me."

"My Ford Ranger & Me."

AMERICA'S
TRUCK **BUILT FORD TOUGH**



Ford Ranger



This One



0XS4-ZYP-1S33

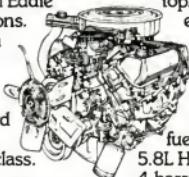
Get it together—Buckle up!

Ford Pickup

More Bauer to you!

Ford Bronco and Bronco II—
not one but two tough
4-wheelers for '85—both with
Eddie Bauer style. They're all
dressed up with everywhere to go!

Now Ford offers you a choice of big Bronco (seats 5 or 6) or trim-size Bronco II (seats 4) in special Eddie Bauer editions. Both have a lot of good things in common—besides Ford toughness and Bauer class.



More power to you.

Both have plenty of power on tap. Power that eases you through hard off-road going and makes

all driving more fun. Bronco II's 2.8L V-6 gives you power no other small V-6 4-wheeler can top. It's standard at no extra cost. Bronco starts with a big high-torque 4.9L Six, standard. Adds a 5.0L V-8 with new electronic fuel injection. Plus a 5.8L High Output V-8 with 4-barrel carb—and 27% more horsepower than Blazer's biggest engine.*

Unique suspensions.

Both Broncos have

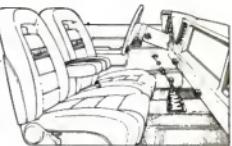
independent front suspension to absorb off-road jolts so you don't have to. And to help keep wheels glued to the ground for solid traction.

Both give you a proven 4-wheel-drive system with a choice of manual or optional automatic locking hubs.

And now both offer you the special looks and luxury of Eddie Bauer editions.

The Bauer Broncos.

These unique 4-wheelers have high-styled interior and exterior trim. They include dual Captain's Chairs, floor console and much more. Plus Eddie Bauer gear bag, travel blanket and visor organizer. And, to top it all, "Ford Care" extended maintenance



and limited warranty program. One beautiful package!

Best-Built American Trucks.

At Ford, Quality is Job 1. A 1984 survey established that Ford makes the best-built American trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1983 models designed and built in the U.S.

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*Optional; not available in California or with manual transmission. Horsepower based on SAE Standard J1349.



"My Ford Bronco & Me."

"My Bronco II & Me."



AMERICA'S
TRUCK BUILT FORD TOUGH



Get it together. Buckle up.

Passenger

"Work out.
Run.
Sweat.
Shower.

And Speed Stick® protection
to help keep me dry.

That's how I give
my career
an extra edge."



**THE
WIDE
STICK™
GIVES
YOU THE
EDGE.**

by **MENNEN**

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**ON THE COVER**

Looking like men from outer space, firefighters dressed in heat-reflecting suits use a thermal-imaging scope to see through smoke and spot trapped victims. Read about new high-tech gear in battling deadly chemical fires and saving lives. Story begins on page B7.

PM photo by
Brian Wolff

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AND BIKES**

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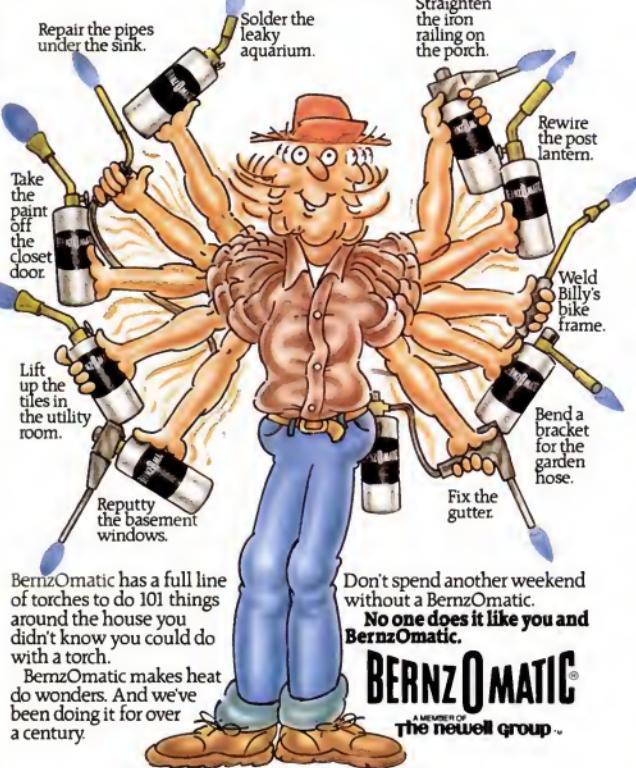
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With BernzOmatic you won't know what to do next.



BernzOmatic has a full line of torches to do 101 things around the house you didn't know you could do with a torch.

BernzOmatic makes heat do wonders. And we've been doing it for over a century.

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Purcell Mountains. A rugged place for a smooth whisky to start.



WESTERN CANADA—The hardest part of the climbing is just getting enough air. I gulped it in. Icy. Thin.

And then we stopped, and looking around took my breath away all over again.

Later, thawing out by the fire, we knew we'd been someplace we could never forget.

Over Windsor Canadian, we talked about it all night long. That's some smooth whisky.

It's made from water that runs down from the glaciers. They use the local rye. And that high, clean air must have something to do with the way Windsor Canadian ages.

Rugged country. Smooth whisky. Both unforgettable.



WINDSOR
CANADA'S SMOOTHEST WHISKY.

True Value
HARDWARE STORES

TOOL VALUE OF THE MONTH



399

Servess® 2-Pc. Locking Pliers Set

7" regular & 6" long nose pliers with adjustable heat-treated alloy steel gripper jaws. Hurry! Offer good from Feb. 10 only while supplies last, at participating True Value Hardware Stores. LP607



**HARDWARE
VALUE
OF THE MONTH**

10⁸⁸

KELLER® 27"

Aluminum Stepladder
Lightweight, features full 3" side rail, slip-resistant steps & feet, pinch-proof spreader bar. Hurry! Offer good from Feb. 20 only while supplies last, at participating True Value Hardware Stores. 327

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For store nearest you, see
"Hardware" in the Yellow Pages.



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EDITOR'S NOTES

Moving a piano may not seem to merit a place in history. At least not until you've suffered through the effort yourself. The move does take on a certain stature when you do it alone, in darkness, and in absolute silence. Humorist Victor Borge recounts such a feat in *How To Move a Baby Grand* (page 107). Borge's is just one of our *Great Moves Of History*, which you'll find on page 100. One great effort that didn't quite make our final cut but is nonetheless interesting is shown below. It involves the unorthodox treatment of an Orthodox church in Czechoslovakia. When a coal deposit was discovered under the church in 1975, the 12,000-ton building was elevated, placed on rails and hefted a half mile away so the coal could be mined. (By the way, it should be noted that for his effort, Victor Borge was made PM's Music Critic for this month—the first man ever to be so honored). . . . It takes a lot more to fight a fire nowadays than a hose and a hardhat. With all the new kinds of materials that can burn—chemicals, plastics, toxics—there's no telling what firefighters will face when they respond to a call. To make the odds a little more in their favor, they're toting along the equipment you'll see in our cover story, *Hot New Gear For Firefighters* (page 87). To get PM's cover, photographer Brian Wolff and Science Editor Dennis Eskow



Moving a church: Better founded upon a rock than on a prime deposit of coal.

visited the Nassau County Fire Service Academy on Long Island, N.Y., where Alert Engine Co. No. 2 of Rockville Centre was practicing on an oil blaze. Posing calmly are Capt. William Ruckdeschel of Alert, Chief John Baroni of the academy and Chief John Glynn of Alert.



Entertainer Victor Borge demonstrates the first step in becoming PM's Music Critic.

John A. Silletto

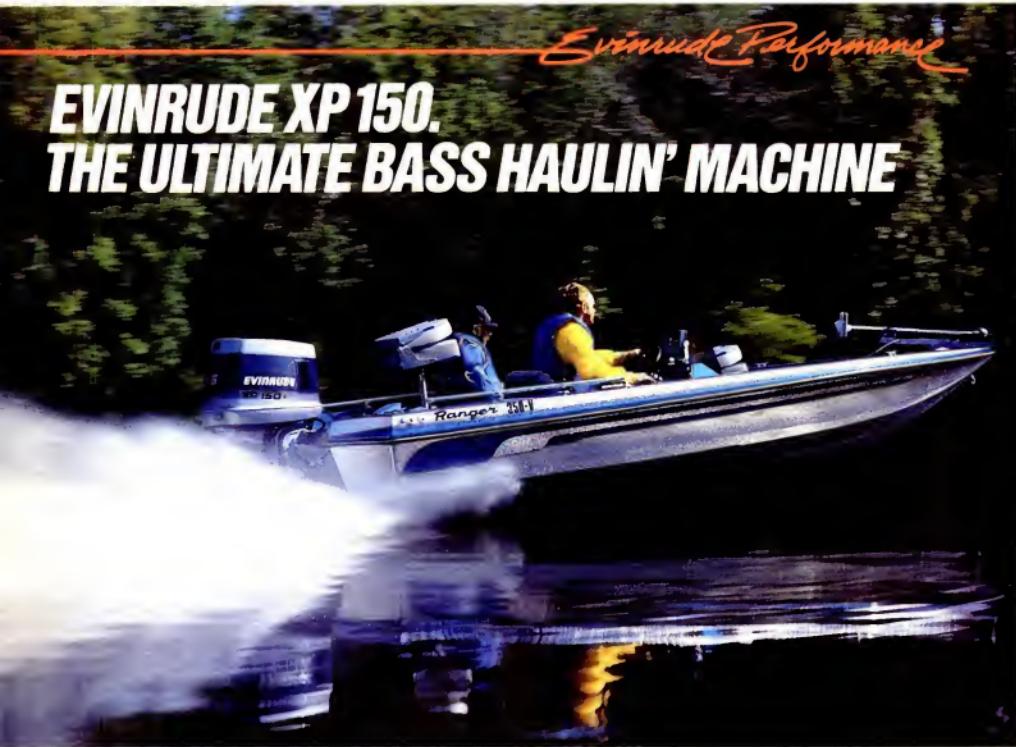


With our cover fire conquered, firefighters and editor Eskow face the camera.



Evinrude Performance

EVINRUDE XP 150. THE ULTIMATE BASS HAULIN' MACHINE



On the pro bass circuit, every tournament is a race. That's why we've engineered so many race-proven features into the Evinrude XP 150.

In fact, it shares many of the same high-tech features that make the new Evinrude 3.6XP™ V-8 so awesome.

Like highly tuned race-style carbs, "high squish" design cylinder heads, a throaty race-tuned exhaust system and sleek Nitro Series™ XP gearcase.

With its Top Charge™ 35-amp alternator, you get more than enough power for fishfinders and other electronic accessories. Quicker charging for your trolling motor batteries, too.

What's more, the XP 150 offers VRO™ variable ratio automatic oil injection.

And the XP 150 is backed by the new

optional 1+2™ three-year buyer protection plan. See all the exciting new Evinrude motors for 1985. For the name of your nearest Evinrude dealer, call this toll free number: **1-800-255-2550.**

THIS YEAR GO FOR THE BEST.

EVINRUDE

**FIRST IN
PERFORMANCE OUTBOARDS**



LETTERS TO THE EDITOR



Solar slip-up

I was puzzled by your explanation of why it was possible to photograph a normally unphotographable annular solar eclipse (*Science Worldwide*, page 52, Oct. '84). In an annular eclipse, as I understand it, it's the brightness of the sun showing around the edges of the disc that blanks out the fainter corona, making it invisible and thus not possible to photograph.

But you said that the sun was brighter than usual that day, making the corona visible. Wouldn't that tend to make it even less visible?

HARRY CHURCH
LEBANON, ILL.

You're right. We should have said that the corona, not the sun, was brighter than usual, making it visible despite the presence of sunlight.

I was very interested in your striking



Sun about to disappear in annular eclipse photographed by reader Conant in May 1984.

photo of the solar eclipse because I, too, wanted to photograph it and didn't think it would be possible. I was very surprised and pleased to find that my photos turned out well, although not quite as dramatic as yours.

The photograph that I'm enclosing (above) shows the sun as a slim crescent shortly before total eclipse.

CLAUDE HUGH CONANT
CHARLOTTE, MICH.

Were you there?

During World War II, America lost only one aircraft carrier in the Atlantic Ocean, the *USS Block Island* (CVE 21). Miraculously, all but 10 of the more than 900-man crew survived. These same crewmen were later assigned to a newly commissioned ship also named the *Block Island* (CVE 106).

This continuity of service through the sinking of one vessel and the manning of another of the same name is unique in naval history. We are trying to track down these valiant men in order to set up a reunion. If any are among your readers, we'd like to ask that they contact Al Dulman, 330 Powell St., Stoughton, Mass. 02072. Thanks.

W. J. BOOI
ANCHORAGE, ALASKA

Needs bigger lungs

My husband just finished building your intriguing air-driven calliope (*Create Your Own Circus Music*, page 102, Dec. '82). We found it hard to believe that such a complicated instrument could be constructed in the relatively short time you specified—only 40 hours—but you were right on the money.

We did make one modification that may be of interest to other readers who

have built the calliope. We found that the two hair dryers recommended for the air supply didn't have quite enough volume to produce a full, rich tone. We hooked up a tank-type vacuum cleaner instead and now the calliope sounds much better. We're very pleased.

BEVERLY ELWELL
EDINA, MINN.

Missing tool

Your excellent November '84 issue was a clear example of why I subscribe to PM. So much for the pat on the back. Now for a wrap on the knuckles:

Nowhere in your article *Plan A Shop That Works For You* (page 156) was there any mention of a multipurpose power tool. My Shopsmith takes up only a little more space than a lathe and can match the capabilities of most advanced workshops having many different types of tools. Why the oversight?

TOM ZMUDZINSKI
OXON HILL, MD.

The Shopsmith is a fine tool, indeed, and is particularly useful where shop space is limited because of its many functions. Our article, however, was intended to suggest efficient layouts for those having or wanting a variety of individual power tools.

Tire choosing made easy

Thanks for your article *How To Pick The Right Winter Tires* (page 72, Jan. '85). With all the confusion over different snow treads and front- vs. rear-wheel drive, your clear and detailed information was very helpful.

JOHN C. ACKERNECHT
ESSEX JUNCTION, VT.

In Dutch

I very much enjoyed your article on new ultralights, especially those fantastic replicas of World War I fighters (*15 New Kit Planes You Can Fly Without A License*, page 90, Dec. '84). As a Dutchman, however, I must take exception to your description of the Fokker Eindecker as a German plane.

All Fokkers were, and still are, Dutch-made. The Fokker company is alive and well in Amsterdam and today makes short- and medium-range airliners.

J. J. VAN LIER
MERRIMACK, N.H.

You're right, of course. We meant that the Fokker Eindecker was German in the sense that it was one of Germany's principal fighter planes in World War I.

Your statement that Wisconsin requires mandatory flight training for ultralight pilots was incorrect. This state requires only that ultralights be registered.

For those who insist that ultralights need stricter regulation, it should be noted that no innocent bystander has ever been killed or injured by an ultralight. The only casualties have been among pilots and they assume the responsibility for their own safety.

MICHAEL SCHEID
EAA ULTRALIGHT CHAPTER 36
MADISON, WIS.

Right bridge, wrong river

In *PM's Time Machine* for December '84 (page 182), you noted that construction of New York's Verrazano-Narrows Bridge was begun 25 years ago, but you somehow put the bridge over the Hudson River. I think you'll find that it spans the Narrows, the body of water for which it is partly named.

L. A. BJONNES
HAZLET, N.J.

17 mg "tar," 1.3 mg nicotine av. per cigarette by FTC method

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.



Two men are shown in the cockpit of a helicopter. The man on the left is wearing a yellow and black flight vest over a dark jacket, and the man on the right is wearing a dark flight jacket. They are both wearing gloves and appear to be working on the helicopter's controls. The background shows a snowy landscape and a clear blue sky.

Winston America's Best.

Excellence.
The best live up to it.



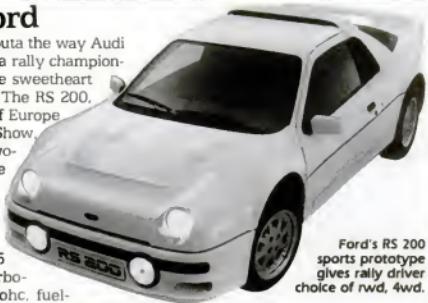
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IMPORTS & MOTOSPORTS



Flat-out Ford

Look out Lancia and outa the way Audi Quattro! Ford's after a rally championship. This stubby little sweetie looks fast and is fast. The RS 200, just shown by Ford of Europe at the Torino Motor Show, is a mid-engine two-seater that will run the roads with driver's pick of two-wheel or four-wheel drive. He'll be kicked up to 60 mph in under 5 sec. by the turbocharged, 16-valve, dohc, fuel-injected Four that sits fore and aft behind him. The 1.8-liter powerplant will develop up to 360 hp in a chassis that's got a right-on weight distribution of 50:50. The composite materials body is a Ghia Studio design and, even



Ford's RS 200 sports prototype gives rally driver choice of rwd, 4wd.



Turbo intercooler of the mid-engine RS 200 is aerodynamically integrated in the roof.

though it appears totally new, if you look closely you'll see some parts taken right off the Merkur—the windshield, for example. The front and rear body sections hinge open completely, and all drive train components are fully accessible for quick servicing during rallies. In 10 minutes, you'll get a complete transmission change! Four prototypes were built initially and tested by Jackie Stewart, who gave the RS 200 thumbs up on its performance and handling. To qualify for world rally competition, Ford will build 200 cars to be sold in Europe. No matter that the price should be about \$40,000—a line is already forming.

Volvos with front-wheel drive

If you're familiar with Sweden's two automakers, you know that Volvo has always made the rear-wheel-drive cars and Saab the front-wheel-drive models. That's just the way it's always been, but not for much longer. Late this year, Volvo will show the first of a fwd range of cars that'll join familiar DL, GL, 740 and 760 models that are sold here. The front drives

Four-door version of new front-drive line shares front-end identity with Volvo's 760 flagships.



will be smaller than the "big" Volvos we know, and—good news for fans of the marque—less expensive. They'll be built in Volvo's manufacturing plant in Holland and will be 1986 model-year cars. The sports coupe should be the fastest of the new models, and will compete with cars like the Volkswagen Scirocco. The four-door



Volvo fastback sports coupe will be first front-drive car from the Swedish automaker.

Taller wagon

No, you're not shrinking. Some Honda Civic wagons are 1.1 inches taller than you remember from last year. The four-wheel-drive model, which just went on sale in snow-belt areas of the country, is higher to make room for a prop shaft to a rear axle differential, and to give the model a little extra ground clearance. The 4wd is an on-demand system: All you do is hit a button on the instrument panel when you want additional traction.

The only gear box offered is a six speed. The sixth-gear position is off to the side, out of the way of Honda's familiar five-speed shift pattern, since it's an extra low gear designed for low-speed pulling power when in



Honda Civic wagon with four-wheel drive is 1.1 in. taller than its fwd counterpart.

4wd. Power to the wheels is from Honda's transverse, 1.5-liter, 12-valve Four with 76 hp and 84 lb.-ft. of torque. With this mountain machine, you can leave your crampons at home.

sedan gets an aerodynamic shape with some resemblance to the 700 series body. It's roomier than the model it has been built to replace: the rear-wheel-drive 360 that has been available only in Europe.

Meanwhile, at the upcoming Geneva Auto Show this month, Volvo will be showing a limited-production, 760-based, luxury performer—with, of course, rear-wheel drive.



**Now they last even longer.
(Once again, Duracell delivers.)**

At Duracell, neither rain nor snow nor dark of night stays us from trying to find ways to improve our batteries.

Not an easy task, mind you.

DURACELL® batteries are, after all, famous for their long life. And rightly so.

But try we did.

The result: Today's DURACELL batteries last up to 20 percent longer than the ones we made three years ago.

And we'll keep on improving them.

So no matter what you need batteries for, count on Duracell.

Our delivery is strictly First Class.



**When it comes to making them last longer,
we never stop.**

A quick message

We'll be brief. The car shown here is the most powerful Civic ever.

It's the new Honda Civic CRX Si. It has fuel injection. Driving enthusiasts will have no objection.

Fuel injection is just another way to get gasoline into the engine. Simply, it does the job more efficiently than a conventional carburetor.

Honda calls its new sequential-port system Programmed Fuel Injection. It times the exact moment to inject a precise measure of gasoline into each cylinder. The engine says when.

A 12-valve, cross-flow cylinder head makes effective use of the new fuel injection. Which makes it easier for you to get around slow moving traffic.

The CRX Si was designed for pure driving enjoyment. It comes only with a 5-speed manual transmission. Fifth gear is a true overdrive. It helps overall economy and reduces engine wear and interior noise level.

As always, you will find the engine and transmission up front for all the advantages of front-wheel drive. Less weight, more space, better traction.

One thing that makes the CRX Si a joy to drive is its suspension. Fore and aft stabilizer bars help control body lean while cornering. We've enclosed the rear bar inside the axle tube to keep everything neat underneath.



We've mounted nitrogen gas-filled rear shock absorbers to provide stable dampening. They help improve the ride.

Stopping power is trusted to power assisted brakes. Ventilated front discs help dissipate heat buildup. Rear brakes are drum type. Backing up everything is a dual diagonal hydraulic system.

Rack and pinion steering insures a positive feel to what's happening on the road. The car will positively turn on a dime, providing its diameter is no less than 29.5 feet. The Civic CRX has the tightest turning circle of any two seater sold in America. No wonder it's so easy to park.

In motion, the car is something else. A low 0.33 coefficient of aerodynamic drag. Honda designers shaped the car to direct air around it cleanly. To further improve total efficiency and help road holding ability.

Now you can see why there are so

Change from Honda.



many aerodynamic features. Like a front air dam, flush windshield and door handles, low hoodline and rear spoiler. The CRX is slippery.

You can watch the air slipping by overhead. The CRX Si comes with a power sunroof. Just touch a button and the sunroof panel rises and retracts. Because of the special way it opens, its opening is larger than other designs would permit. And it takes up hardly any headroom. Only Honda has it.

You will find cast aluminum alloy wheels on the standard list. They are fitted with wide Michelin steel-belted radials. Anything less wouldn't be right.

There is a rear window washer and wiper. A big help with a window that's 980 square inches of glass. It also has an electric defroster.

All the windows are tinted to filter out sun rays. The windshield has a dark shaded upper area across the top.

You adjust the dual outside mirrors from inside the car. And you can turn on the headlights, signal turns, wipe and wash the windows quickly, slowly or intermittently. Without removing your hands from the steering wheel.

Tall people can sit in this car. The seatbacks recline and the bucket seats themselves adjust eight inches front or back. Legroom runs nearly 43 inches. The seats have adjustable headrests.

Right behind the bucket seats is a locking stowage compartment. For anything you don't want people to see. There is also 14.5 cubic feet of cargo space back there. With a wide rear hatch for easy loading and unloading.

On the dash panel you will see the instruments you need. These include a speedometer with odometer and trip odometer, tachometer, temperature and fuel gauges and functional warning lights. They are illuminated in high visibility orange for better night vision, like in airplane cockpits.

The rest of the instrument panel features door window defrosters, quartz digital clock, covered storage box. And finally, a coin box.

Certainly, by now, you must have gotten the message.

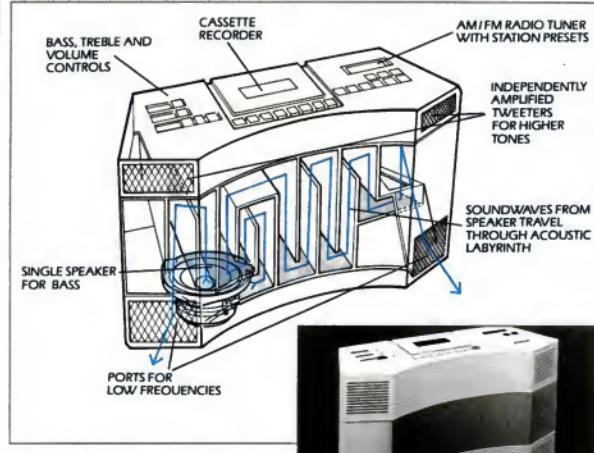
HONDA

The Civic CRX Si

PM ELECTRONICS MONITOR



Breakthrough in loudspeakers



Arrows chart the path of sound through the intricate wave-guide labyrinth (above) that lets the Bose AWMS-1 produce deep bass and high volume. The cassette/tuner/amp (right) is a tabletop model.

To get deeper bass from a conventional loudspeaker, you must increase the size of the cone, house it in a larger enclosure and pump in more watts to move a greater volume of air. Now, Bose Corp. has thrown convention to the winds with an engineering innovation that permits a small, modestly powered speaker to deliver bass at sound-pressure levels usually found only in heavily amplified floor-standing speakers.

The new technology is so effective that its first application occurs in a small, self-contained hi-fi console. Bose calls the Acoustic Wave Music System (AWMS-1, \$649). The tabletop unit includes an AM/FM tuner with 10 presets, a cassette recorder with Dolby-B noise reduction, a 25-watt amplifier for the single 4-in. bass cone and a five-watt amp for each of its two high-frequency speakers. All this comes in an 18-pound package only 18 in. wide, 11 in. high and 8 in. deep.

Critical to the system's size and operation is the acoustic wave technology it's named for. This involves controlling

the interaction of acoustical waves with the moving bass cone. Similar to the way a flute can fill a hall with sound from a mere whisper of breath, this interaction takes place within tubes—or wave guides—emanating from the speaker cone and folded at precisely calculated intervals. A conventional speaker of the same enclosure size as the Bose AWMS would need three times the amplifier power to achieve the same volume.

According to Dr. Amar Bose, the compact efficiency of wave-guide technology has applications in video and car stereo. The wave guide can be wound through a TV set to produce astounding stereo from a small amplifier. Winding the wave guide around obstructions in a car would permit greater installation flexibility for super hi-fi sound.

Although the company is introducing its technology in a simple, one-piece console, Dr. Bose says free-standing wave-guide speakers are feasible for home and commercial use. The AWMS-1 runs on household current. A carrying case with battery pack costs \$70.

Currents

- By the time you read this, the first Compact Disc "singles" should be available. PolyGram Records says its MaxiDiscs will contain 17 minutes of digital audio music on a standard 4 3/4-in. CD that is priced lower than album-length CDs. One possible application: laser jukeboxes.

- The interception of pay-TV programming by home satellite-dish owners is now legal, thanks to the 1984 Communications Act. But some pay-cable programmers are threatening to scramble their signals this year to foil free-loaders. Stay tuned

- Signal-swipers beware: Those black boxes for unauthorized scrambling of pay-cable programs might cost you more than you think. A Federal District Court recently slapped \$1.1 million in theft-of-services fines against a New York retailer who sold the devices. The cable companies say they'll pursue cases against individual owners, too.

Hand-held computer-fun

Add SuperMicro to the list of downsized electronics miracles. HomeComputer Software, its maker, describes the device as a palm-size computer console for game aficionados whose skills and tastes have outgrown simpler handheld video games.

At \$59.95, the battery-powered SuperMicro enables computer buffs to enjoy mind-challenging games away from their home computers. Its twin microprocessors and liquid crystal display color screen provide multiple skill levels, game variation and random action, along with sophisticated color graphics and sound effects. The game cartridges pop into the console like cassettes. HomeComputer Software now offers three games, with more cartridges on the way.



The color liquid crystal display screen of the SuperMicro game console closes up like a clamshell for portability.



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B6200	15	3	Standard
B7200	17	3	{ Standard or
B8200	19	3	Hydrostatic
PTO HP*			
L245 HC	21	3	Standard
L2250	21	3	Mechanical shuttle-shift (8x7)
L2550	23.5	3	Mechanical shuttle-shift (8x7)
L2850	27	4	Mechanical shuttle-shift (8x7)
L345	29	4	Standard
L355 SS	29	4	Hydraulic shuttle-shift
L3750	36	5	{ 8x8 or
L4150	40	5	Hydraulic shuttle-shift

*Manufacturer's estimate

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APPLIANCE CLINIC



'Chocolate' ice cubes, then none

I have a General Electric icemaker, Model GE1, No. WR30X186, in my GE refrigerator. Dirt and sand entered our water supply from a ruptured water main in the street, and since then the icemaker hasn't worked. It made two or three cycles of "chocolate" ice cubes, then two cycles of clean but half-size cubes, and after that, nothing. What can I do to remedy this? My water supply is now clean and with good pressure.—T. Moitoza, Metairie, La.

Apparently silt that went through the water supply clogged the filter screen in the icemaker water valve. This valve is located in the motor compartment at the rear of the refrigerator. To clean the screen, unplug the refrigerator and turn off the water supply to the icemaker. Move the refrigerator away from the wall and remove the rear access panel.

Follow the water supply tubing to the water valve. Use a wrench to disconnect the tubing from the valve. Then remove the large brass hose nut to gain access to the stainless-steel filter screen located inside the valve inlet.

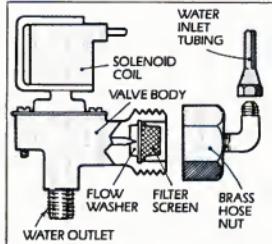
Remove the screen by carefully working it out of the valve with a small screwdriver. Clean the screen thoroughly, then replace it in the valve.

Before reconnecting the water supply tubing, place the loose end in a bucket and have someone turn on the water supply briefly, to flush about a

quart of water through the tubing. Reconnect the tubing, turn the water back on, and check for leaks around the connection. Plug in the refrigerator and make sure the icemaker is turned on and plugged into its connector in the side wall of the unit's freezer compartment.

To prevent debris and silt from

blocking the icemaker valve in the future, you might consider installing a water filter on the tubing leading to the icemaker water valve. The filter will also strip out much of the chlorine in the water and make the ice cubes taste better. The water filter is available from any authorized GE parts distributor in your area, and comes with installation instructions for the do-it-yourselfer. The part number for the filter is WR97X214.



Icemaker water valve, if blocked by sediment, needs filter screen cleaning.

Calibrating an oven

The oven temperature control on my Frigidaire electric range, Model RDG3-35W, seems to be off about 50°. For example: When preheating the oven on a setting of 350°, the oven pilot shuts off, but the oven heat will override to about 400°. Would you please tell me the best way to approach this problem. I have had the back panel off to replace a surface unit pilot and found some loose wiring, which I took care of.—Albert Gibson, Port Richey, Fla.

To check the oven temperature, place a mercury oven thermometer—available at any large hardware store—in the center of the middle oven rack. Close the door and set the thermostat dial to 400°. Allow the thermostat to cycle off and on for three cycles (watch the indicator light). Use a flashlight to read the thermometer through the glass door, and calculate the average oven temperature for the last cycle. Mark down the cut-on temperature (indicator light on) and the cut-off temperature (light out). Add these two figures together and divide by 2. If the average temperature is less than 390° or more than 430° the thermostat should be recalibrated. If it is less than 290° or more than 530° the thermostat should be replaced.

To recalibrate the thermostat, the oven dial should be left at 400° and the oven hot. Remove the control knob; the calibrating screw is inside the hollow shaft on which the knob mounts. Insert a very thin-blade screwdriver through the center of the shaft to engage the calibrating screw. Hold the outside of the shaft with pliers to prevent it from moving, while turning the adjustment screw counterclockwise until the oven light comes on. Then, turn the screw clockwise until the oven light goes out. Set the screw approximately halfway between these points.

Let the oven cycle twice, then recheck the average temperature. On your particular model range, moving the calibrating screw 1/4-turn counterclockwise lowers the temperature approximately 35°; 1/4-turn clockwise raises the temperature 35°.

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

Spin cycle shuts off clothes washer

I have a Sears Lady Kenmore clothes washer, model No. 110.72490600, serial No. C40702298. Every time the spin cycle begins, the kick-off switch shuts off the machine, no matter what the size of the load. I've checked to make sure the washer is level. Can you help?—Bernard Smith, Everett, Pa.

Either the snubber pad and spring are worn, or the off-balance switch needs adjusting. To check the snubber pad, unplug the washer, then raise the top by inserting a thin-blade putty knife between the top and the cabinet and pushing in on the two top locks, located 2 1/2 in. from each side. The snubber pad and spring are at the right rear corner.

Push the tub back all the way, then let go. The snubber should produce a

drag on the tub and stop it from swinging back quickly. Should the tub move too freely, there may not be enough tension on the spring, or the bottom of the snubber pad may be glazed or oily and need replacement. The snubber and spring is part No. 350902, available at any Sears parts or appliance store.

If the snubber pad and spring are not the problem, check the off-balance switch. The switch is located behind the access panel at the rear of the machine, mounted with two screws to the left inside of the cabinet just below the base plate. There should be about 1-in. clearance between the base plate and the thin metal trip lever of the switch. If there is less clearance, bend the metal arm away from the base plate.

THE PM GARAGE

Tattletale ignition

The newest wrinkle in automotive electronics is self-diagnostics—systems that can analyze, store and report on their own failures. These systems are popular standard equipment on new cars, but here's the first I've seen in aftermarket parts.

The SecurityPlus electronic ignition module is a plug-in, bolt-on replacement for 1974 and later Ford vehicles. Two indicator lights on the case display module status. A green LED lights as long as the module is working properly. Should there be a malfunction, the red indicator light comes on and stays lit. That's really useful in cases of intermittent failures, where the unit malfunctions when hot and works properly after cooldown. If that happens, the red light would tell the tale.

SecurityPlus also prevents mistaken replacement of a working module, an error that might cost up to \$100. A limited lifetime warranty on the module stipulates free replacement if the red indicator light ever comes on. It's available at auto parts stores for about \$50. For more information, write to Switches Inc., 516 High Street, Logansport, Ind. 46947.—N.S.M.



Replacement Ignition module uses LEDs to report on its own status.

Proper venting



Vent system traps the electrolyte overflow and safely carries away hydrogen gas.

The Safety Vent System is designed to prevent a buildup of explosive hydrogen gas inside the battery. Instead, hydrogen vents from the battery into the recovery monitoring bottle. A $\frac{1}{4}$ -in. hole in the bottlecap allows gas to discharge into the atmosphere, away from the battery terminals, where a spark might ignite it. If $\frac{1}{4}$ in. or more of electrolyte is found in the bottle after 30 days, it means the battery is being overcharged or too much water was added to the cells.

The Safety Vent System can be used on most nonmaintenance-free batteries. It's \$11.95 by Cable Safety Systems, 729 Walnut Blvd., Brentwood, Calif. 94518.—Mort Schultz

Third hand at the gas pump

Every time I suffer through frostbite and gas-soaked hands at the self-serve station, I fume about the demise of automatic gas pump nozzles. The solution is so simple that you'll wonder why it's not been thought of before—a clever plastic helper called the E-Z Pump. Hook it in place (either fast or slow filling speed) and you're free to check the oil, clean the windshield, or simply get back into the warm car. They're \$1.25 each from Ventures Unlimited Inc., 1165 Clifton Ave., Akron, Ohio 44310.—N.S.M.



Simple clip automates the gas-pump nozzle.

One cure for a shaky Four



Torque Strut replaces worn-out rubber engine retainer straps with a spring hydraulic unit and cuts vibrations.

Why does engine vibration seem to increase as my four cylinder, front-drive car adds up the miles? The upper portion of the engine is secured to the radiator support by a strap that will wear out due to continuous flexing and heat/oil exposure. The Torque Strut is a spring-and-hydraulic replacement that eliminates failure-prone rubber bushings. Priced from \$40 to \$50 for GM A- and X-cars, Honda Accord and Civic, the Moog Automotive struts are available at auto parts stores.—W.H.

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THE PM WORKBENCH



Step up to a new drill bit

Petersen Manufacturing has redesigned one of the simplest tools—the drill bit. The new Unibit drills are tapered with multiple, stepped cutting



Three of the 16 Unibit models are shown above (left to right): the Unibit 1, 3 and 11. Each step bores a larger size hole.



Because of their tapered, single-flute design, Unibits bore through dense metals easily. The hole enlarges step by step.

edges. This allows one bit to bore different sized holes in most building materials. For example, the Unibit 1 bores 13 different diameter holes, thus replacing several standard drill bits. This somewhat justifies the high cost: Bits start at about \$18 each.



The nonskid tip starts on curved surfaces such as pipe and conduit. Stop boring when the desired hole diameter is reached.

Unibits were developed for metals, but the single flute cutting edge works well for boring through wood, composition board and acrylic plastic. The sure-start tip eliminates walking and center punching. Unibits are available in standard and metric sizes. For more information, contact Petersen Manufacturing, Customer Service, DeWitt, Neb. 68341.—J.T.



The high-speed steel bit can also be used to cut through particleboard and plasterboard. Move the drill with a sawing motion.

A thinking saw

Porter-Cable's Speedtronic 7 1/4-in. circular saw (\$199) has a microprocessor that maintains a blade speed of 4,500

rpm, whether the saw is idling or under load. A panel of warning lights tells if the saw is operating normally (green light), at the maximum rating of 14 1/2 amps (yellow light) or if the amp rating is being exceeded (red light). For details, you should contact Porter-Cable, Advertising Dept., Box 2468, Jackson, Tenn. 38302.—J.T.



Microprocessor monitors the motor 30 times each second, then adjusts the power to maintain the blade speed. Warning lights (inset) relay the saw's operating condition.

Powerful paint stripper

Stripping paint is a messy, time-consuming job that no one enjoys. But now, Wagner offers an electric heat gun that makes removing finishes easier and neater. The Power Stripper is a safe, flameless way to soften old paint and varnish from a variety of surfaces including wood, metal, tile and concrete. The 1,400-watt unit reaches a tempera-



Power Stripper comes with a concentrator and flare nozzle. The flat-back design allows the tool to stand upright to cool.



Apply heat until the paint starts to blister, then remove it with a putty knife or scraper. It works on both latex and oil paints.

ture of over 1,100° F. It's also handy for thawing frozen pipes, drying plaster, melting soldered joints and for softening adhesives and caulk. The Power Stripper (\$60) is available at hardware stores and home centers. Contact Wagner, 1770 Fernbrook Ln., Minneapolis, Minn. 55441.—J.T.

Icebox update

An incorrect box number was given for ordering hardware for the icebox shown in our December '84 issue (*Build An Old-Time Icebox*, page 102). The correct address is Armor Products, Box 290, Deer Park, N.Y. 11729. Orders already sent will be redirected or returned by the Postal Service.

If you've come across a new product with some special features, let us know about it. Write to PM Workbench, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019.

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Black & Decker has joined with millions of Americans to fund the restoration of the Statue of Liberty. But money isn't all we're giving. As a leading manufacturer of power tools and accessories, we're also donating our time, experience, and a whole line of tools to keep Miss Liberty strong.

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The BFGoodrich Euro Radial T/A® was designed to function as a component of your car's suspension system. Specifically, sidewall flexing helps compensate for camber changes, while belts supply the rigidity needed to maintain more road contact under cornering.



Most enthusiasts look for a tire that improves a car's cornering as much as its looks. While no tire can claim the ultimate in any performance characteristic, it is a fact that the BFGoodrich Euro Radial T/A is capable of far higher cornering forces than you would normally experience on any car on any public road.

The same basic computer-aided technology used in building the quick-cornering BFGoodrich Euro Radial T/A (in 60 and 70 aspect ratios) was applied to the entire family of T/A® Radials. The result is a complete line of high-performance car and truck tires in many sizes, designed for a wide variety of performance needs and driving styles.

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equalizer—is designed into the vans on the drawing board. So it's tuned to their unique acoustical environments.

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Equalizer V's Electronically Tuned Receiver (ETR™) is engineered for drift-free reception. And a new auto-reverse cassette player, with music search and repeat, doubles your musical options.

The system's graphic equalizer lets you conduct a quintet of bass, midrange and treble controls to score the music to your individual taste.



Equalizer V

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HOMEOWNERS' CLINIC



An end to broken window sash cords

I have double-hung windows in my home, with cords and weights, and I'm getting tired of fixing broken cords. Could you tell me how to replace them with springs? What types of springs are available? Also, after I replace the cords and weights, how do I insulate the hollow space and what type of insulation should I use?—Charles J. Koegel, Syracuse, N.Y.

If you like the lifting action of the counterweight on the double-hung window, you should replace the broken sash cord with metal chains, which are available at hardware stores. The chain won't fray or become brittle with age and break.

You can also replace the weights and cords with metal pressure channels. These channels do not provide lifting action, but they have spring-action strips on both side jambs that hold each sash securely in any position. This ensures a snug fit that prevents rattling and minimizes cold air leaks.

One brand of easy-to-install channels is Window Fixer Replacement Window Channel. The first step is to remove the inside trim or stop molding from the sides of the jambs and remove the sashes from the frame. Then, cut off the sash cords, remove the old pulleys and clear any obstructions out of the old channels.

Fit the channels on each side of the sash. Pick up the sash and channels together and place them into the frame. Finally, tack the channels in place and reinstall the trim.

Window Fixer channels are available in hardware stores and home centers and cost between \$12.75 and \$18 per set depending on your window height. They are made by Quaker City Manufacturing Co., 701 Chester Pike, Sharon Hills, Pa. 19079.

Nonskid step coating

I have two brick steps at the side of my house that have become porous. Some time ago, I watched workers applying a nonskid cement coating on subway steps. This would be a perfect material to coat my brick steps.

I've checked and learned that the material I saw being used is made exclusively for transit systems by Edison Cement. Is there a similar product I



Metal channels fit standard 1 1/8-in. double-hung sash. Spring-action center strip holds sash in position, eliminates cord and weights.

Before installing the channels, the wall cavity for the cord and weights can be insulated by loosely stuffing it with fiberglass or Rockwool. You can also pour a loose fill insulation such as vermiculite into the hollows.

If the area is inaccessible, you can fill it using an aerosol foam insulation, such as Polycel-One, which comes in 12-ounce cans costing about \$6. It's manufactured by Grace Construction Products, W.R. Grace Co., Cambridge, Mass., and is available at hardware stores and lumberyards.

can purchase and use at my home?—Arman Ajamian, Leonia, N.J.

There are several products that will provide a nonskid protective coating for floors and steps. However, since a section of your steps is presumably on grade level, and subjected to freezing temperatures, it is important that the coating be able to "breathe" and not act as a vapor barrier.

The Sika Corp. has a product called

Sikatop 121 Broadcast Overlay that can be applied to steps to produce a slip-resistant coating. It is an acrylic copolymer that allows vapor to pass through and thus will not trap moisture. Write to Sika Corp., 875 Valley Brook Ave., Lyndhurst, N.J. 07071.

Surface preparation is very important for proper bonding. If the bricks are glazed or hard-burned, the surface must be roughened first. A wire brush mounted in an electric drill should do the job. In any event, it is recommended that you apply a small amount of the product to a test section to check bonding before covering all the steps.

Reducing a hood vent

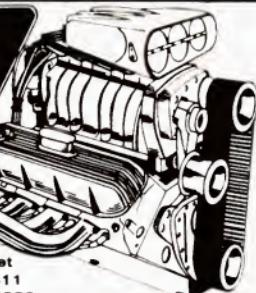
The previous owner of my house installed a kitchen range hood vent that exhausts into the attic. I will soon have my roof replaced and, at that time, will run the vent through the roof. However, the pipe from the hood into the attic has a 7-in. diameter and I want to reduce this to 4 in. before extending it through the roof. Will such a reduction cause a dangerous buildup of grease in the pipe?—J.C. McKinley, Victoria, Tex.

Yes, it could be a problem. The particles of grease that are in suspension will be deposited mainly on the reducing coupling and the walls of the 4-in.-dia. extension. All kitchen range vent pipes should be inspected periodically and cleaned if necessary, but since the reducer and extension would be located in the attic, they would probably be forgotten. The resulting buildup of grease would be a potential fire hazard.

The existing vent pipe should be extended through the roof without reducing its diameter. In addition to being safer, your exhaust fan will operate more efficiently without the added resistance that would result from the reduction. The pipe should be flashed properly at the roof joint, and have a storm collar and a rain hood. Also, if there is no damper over the fan, one should be installed.

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get *PM's Home Care Guide*, \$4.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station New York, N.Y. 10101.

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DETROIT LISTENING POST



J-car nose job for 1986



Bolt-on aerodynamic nose cap with pop-up headlights could transform Cavalier/Sunbird.

This could be the first tentative step taken by General Motors' reorganized Chevrolet/Pontiac/GM Canada Group toward the development of some new products.

I shot this intriguing GM J-car making its rounds in testing at the GM

Proving Grounds. We think this is a proposal for a 1986 redesign of the Chevrolet Cavalier and Pontiac J2000 Sunbird. Most noticeable is the Fiero-like nose cap applied to the car. Hidden headlights are behind small doors that pop up from the top of the new nose.

Running lights and turn signals are the dark horizontal slots just beneath the bumper trim strip. A narrow horizontal air intake is visible in the center of a deep air dam.

Also seen at the GM Proving Grounds was a version of this new nosepiece that did not have the hidden headlight doors. In that version, high- and low-beam headlights appeared in a conventional position.

As GM moves to finalize planning for 1987—when some sources indicate the Pontiac 2000 and Chevy Cavalier will be discontinued—this comparatively inexpensive redesign of a bolt-on part could permit the J-cars to exit as '86s in fine style.

The new nose cap makes economic sense for consumers, too: The better aerodynamics should result in at least marginally better fuel economy.

More French iron for American Motors

Two new AMC/Renaults are on the way. One is a van called the Espace. The other is the Alpine, which you'll recognize from the illustration in PM's January '85 issue (see *Detroit's European Connection*, page 84).

American Motors President and Chief Operating Officer Jose J. Dedeuerwaerder announced during our trip to the Paris Auto Show last October that AMC would begin importing the attractive Renault van in the spring of 1986.

Espace was introduced in Europe last summer (see *Imports & Motorsports*, page 10, May '84), and since its debut has drawn as much praise as any vehicle there since the Alliance, once Europe's Car of the Year. Espace, similar in profile to the Ford Aerostar, will emigrate to the United States at a time when the small-van market is just getting hot. Its front-engine/front-drive power package, seven-passenger design and roomy interior should make it important here—all the more so for its 2.2-liter Four of 110 hp, which AMC says will achieve more than 40 mpg at 55 mph coupled to its standard five-speed transaxle.

There are a few differences between the European Espace and ours. The



Renault's seven-seat front-drive Espace minivan is already a hit in Europe, sells for \$10,600 in France with 2-liter Four.

home-market van gets a 2.0-liter Four, but most other specs are unchanged. Espace will easily snuggle into the family garage with its overall height of 65 in. and width of 70 in. That garage door will close, too—a trim wheelbase of 102 in. will support an overall length of 167 in. and an estimated curb weight

Mid-engined, turbocharged V6 Alpine two-seater will heat up the summer of '86.

of 2,650 pounds.

When I examined the Espace in Paris, I was impressed with its ease of entry and its interior layout. Wide doors open easily and shut securely, and the front seating can be swiveled rearward to permit face-to-face conferences. Controls are easy to reach from a comfortable driver's seat and visibility from behind the wheel is very good.

The Alpine will be imported by American Motors in the summer of 1986. Only "selected Renault dealers in the U.S." will be permitted to sell the

(Please turn to page 30)



For smokers who prefer
the convenience of five more cigarettes per pack.

New Marlboro 25's

Now, famous Marlboro Red
and Marlboro Lights
are also available in
a convenient new 25's pack.



Not available in some areas. © Philip Morris Inc. 1995.

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

Lights: 11 mg "tar," 0.7 mg nicotine—Kings: 17 mg "tar,"
 1.1 mg nicotine av. per cigarette, by FTC method.

DETROIT LISTENING POST

(Continued from page 28)

high-performance pocket rocket, meaning that Michigan's Upper Peninsula may get none, for example, while dealers in urban venues could get several. Only about 3,000 Alpines will be brought over the first year, and they will go fast as well as quickly.

Factory of the future

GM celebrated a ground breaking recently that had to bring a chill to the hearts of UAW members. A new plant at the Saginaw Steering Gear Div. is

where General Motors will build front-wheel-drive axles almost totally by machine. At the ground breaking, officials energized a robot by touching a computer screen, causing the robot to push a chrome spade into the ground and pick up a scoop of soil. Time after time, the creature dropped dirt into a bucket held by a second robot. When the bucket was full, an Automated Guided Vehicle (AGV) made its way to the site, accepted the bucket from the second robot, and wordlessly went away.

According to the plan, when the \$52-million plant comes on-line in late '87, it will be controlled by computers and all

production will be done by machines. People will perform engineering, technical and maintenance duties.

GM Research on-line

We've already reported that General Motors has installed the exotic Cray 1S supercomputer to facilitate faster and better number crunching (see *DPL, page 16, Mar. '84*). After a tour of the GM Research Laboratories at Warren, Mich., we were impressed with what GM is doing with the big computer.

Dr. Robert A. Frosch is the director of GM Research—he formerly headed NASA. He and his colleagues expect the Cray 1S will lead to a future when "practically all of the information needed to build vehicles will be generated initially in computer-based systems."

Programs such as autocolor and autochip change an exterior color or electronic circuit at a touch, and robot eyes can even *find parts on a line*.

Ear to the ground

Mazda builds here: As previously suggested here, Mazda Motor Corp. will buy Ford's unused Flat Rock, Mich., Casting Center and turn it into an assembly plant for passenger cars. Sources at Ford indicate new Mazda 626s and possibly a 626/Mustang will be built there (Ford owns 25 percent of Mazda). First Flat Rockers will be '87s.

Appropriate: GM de Mexico has begun assembly of up to 70,000 *Chevy El Caminos* and *GMC Caballeros*, for delivery to the United States in the next two model years.

GM pays off: At this writing, General Motors has paid 21 claims against its standard insurance policy issued to buyers of new GM cars since April 16, 1984. The policy pays \$10,000 to the estate of anyone killed in a traffic accident while wearing seat belts.

Joint Venture II: Within a couple of months, perhaps in May, GM and Toyota will begin building a *liftback* version of the joint-venture *Nova*, now being assembled in Fremont, Calif.

Ford air bags: Ford will offer fleet buyers of '85 Tempo/Topaz cars an optional driver-only air bag system. The company will study acceptance of the offering. At \$815 list price, Ford says it's losing money on the deal.

Short drives: The '85 *Ford EXP* is a study in contrasts: It's a small car with good mpg and great styling, but it's also hard to park and difficult to see out of. It's a chore to set up a good driving position, and head room is marginal.

Such problems evaporate in the '85 *Chevrolet Caprice*. Big 4.3-liter power is good off the line, but peters out at higher rpm. Rear-seat leg room is enormous, even for 6-footers, and four doors do a limousine make in these downsized times.



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Designed especially for training, your robot duplicates all the key elements of industrial robotics. You learn to operate, program, service, and troubleshoot using the same techniques you'll use in the field. It's on-the-job training at home!

Building this exciting robot will take you beyond the state of the art into the next generation of industrial robotics.

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You get and keep Hero 1 robot with gripper arm and speech synthesizer, NRI Discovery Lab for electronic experimentation, professional multimeter with 3 1/2 digit LCD readout, 51 fast-track training lessons.

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ALL OUTDOORS



Rigid inflatable



A fabric skin and rigid hull give the Achilles high performance at relatively low cost. Combine an inflatable hull with a rigid hull and you get the buoyancy of inflatable tubes and the high performance characteristics of a rigid craft. That's the idea behind Achilles' new Model HB-126, which bonds their hypalon/nylon/neoprene fabric to a modified-V fiberglass hull. Compared to conventional inflatables of the same size, the rigid hull design requires less power to achieve the same speed. The HB-126 also uses an advanced water ballast system with three separate hull compartments. Weight is kept forward longer, keeping the bow lower while the boat evenly rises up on plane. The 12 ft., 6 in. inflatable uses five separate air chambers, has a 5 ft., 4 in. beam and can carry five persons or 1320 pounds. Weight is 198 pounds. The boat retails for \$2,995 and can be had with optional center steering console. For more info, contact Achilles Inflatable Boats, 90 Murray Hill Parkway, East Rutherford, N.J. 07073.

Bizarre bikes



The side-by-side plan requires no welding. Dare to ride a bike that's really different, one you build yourself? All you need to build one of these beauties is square aluminum tubing, hacksaw, pop riveter and plans and instructions (about \$15). Standard bike parts (wheels, drive system, etc.) come from your local bike shop. No welding is required as the square aluminum tube main frame is epoxied and pop riveted together. With little imagination you can use the same construction techniques to build a variety of bikes—recumbents, three-wheelers, golf carts, rickshaws and more. Contact E.T. Cycle, 539 17th Ave. S.W., Calgary, Alberta, Canada T2S 0A9.

Gun block

Here's less than a half-ounce of prevention to stop needless tragedy. Not a gun lock, the Gun Guardian is a gun use

Flexible strap prevents the gun action from operating by accident.



Wheel assembly will multiply the force.

deterrant that relies on tough, flexible safety straps and T-blocks to block the gun action from operating if the firearm is tampered with. Easily installed, the straps can be removed only by cutting or twisting. A quick release metal ring allows quick activation of the firearm. The safety system by Hoppe's Gun Care Co. costs \$2.98 and comes with 10 safety straps and three T-blocks. It's available at firearms and sporting goods dealers. Or write Penguin Industries, Airport Industrial Mall, Coatesville, Pa. 19320.

Dart Gaff

You'll land more of those big ones quicker with the 2-foot advantage you get with the Dart Gaff over a flying gaff. This piece of landing tackle, designed for cockpit use, allows you to strike home earlier in the battle and gaff a fish while it's still green. Dart Gaff's 300 Series stainless-steel blades penetrate the toughest shark skin. The dart is connected to T-316 series, 7x7 strand construction, PVC-coated stainless-steel cable. Anodized handles have nonslip hand grips. Dart Gaff is by SoLo Marine Products, P.O. Box 877, Bridgeport, Conn. 06601. (203) 336-2700.

Dart gaff gives you a 2-foot advantage over the standard flying gaff to snag green fish.

Olds Cruisers.

They handle cargo like a wagon. And people like an Oldsmobile.

When it comes to muscling cargo, the Olds Cruisers can handle the job with the best of them. But what makes these wagons so special is the way they handle people.

Take the Cutlass Cruiser—this year offering an available 3.8L multiport fuel injected V6. With over 74 cubic feet of cargo space with the second seat down, it offers the kind of room you expect from a wagon.

But even better, it offers the special kind of luxury you expect from an Oldsmobile.

Handsome interior appointments. Available seating for eight. And thoughtful conveniences, like the hinged rear window that flips open for easy access to the cargo bay.

Olds Cruisers come in three sizes to fit any size family. With a wide choice of available power trains—4, 6, and 8 cylinder engines—to answer any demand.

So when you have a load to move, move it in a wagon that won't treat you like cargo.

A new Oldsmobile Cruiser.



Custom Cruiser

Futura Cruiser



Cutlass Cruiser

There is a special feel
in an  **Oldsmobile**

CAR CLINIC



Air raids

We're faced with the ever-present threat of bird stuff falling on car finishes. Droppings have to be washed off immediately or spots fade. Can anything be done to restore these areas?—J.E. Gilchrist, Parkersburg, W. Va.

You can attempt to remove the spots by lightly sanding affected areas with 600-grit sandpaper. Then polish with a fine-grade rubbing compound. However, if the acid in the droppings has worked its way through the color coat, you may rub through to primer before eliminating the spot. If this proves to be the case, repainting is the only solution.

A report by Ford Motor Co. suggests that bird droppings now contain a higher percentage of acid than ever before. It has to do with flocks drinking surface water higher in acidity because of acid rain. So be advised—wash off bird droppings as soon as possible. The longer you leave it on a finish, the more risk of damage.

When to put out the cat

No one I've spoken to knows the symptoms that can tip you off to a catalytic converter that needs replacement. As a result, car owners are vulnerable to whatever cost and replacement advice mechanics wish to give. Any suggestions? Also, do you think a Saturday mechanic can replace a catalytic converter himself?—V.J. Adams, Knoxville, Tenn.

There are several conditions that should make you suspect a bad catalytic converter. Obviously, one is failure to pass a state emissions inspection test. Others are an engine that lacks power, stalls, idles roughly or backfires.

Notice I said that these things should make you suspect the converter. They are not proof positive, because each can result from malfunctions elsewhere. It's necessary, therefore, to test for an exhaust system restriction that indicates a bad converter.

This test is done by attaching a vacuum gauge and running the engine at cruising speed, then let the throttle snap closed. The gauge should soar to nearly 25 in. If not, an exhaust system restriction exists that may be caused by a plugged catalytic converter.

Can a Saturday mechanic replace a catalytic converter himself? If it's a monolithic type as used on most Ford and Chrysler models, probably he can.

The procedure for replacing a converter is a little more involved than replacing a muffler. If you decide to tackle the task yourself, be aware that with some models an air line from the air injection reactor attaches to the converter. Air injection assists in the catalytic treatment of pollutants, so you should make certain this line is reattached securely.

If you encounter a bead-type catalytic converter, which is used mainly on GM vehicles, the converter housing can be reused if it isn't dented. Catalyst beads inside the housing are replaced, but this job will require special equipment that a Saturday mechanic is not likely to have. This task, then, is best left to a service technician.

However, monolithic-type converters are available as GM replacements through aftermarket manufacturers. Check with your local parts store. Since very few stores stock these converters, your counterman will probably have to order one for you.

How can you tell which converter you have on your car? You should examine the housing. A bead-type unit will have a plug in the housing—a monolithic converter won't.

Caution: Catalytic converters get red hot. You should never go near one unless the engine has been shut down for at least six hours.

Taking the lead on lead

What alternative will be available when leaded gas is phased out? I have a 1969 Pontiac Catalina which I bought new, that's in mint condition. I'm sure many others have older cars like mine and need help.—Larry Clark, South Burlington, Vt.

You're right. I've received a bundle of letters which indicates confusion concerning the proposal by EPA to do away with leaded gasoline. Owners of older cars fear that phasing out leaded gas will force them to use unleaded gas, resulting in engine valve damage.

Lead in gas builds up a veneer around valve seats that supposedly protects non-hardened valves in older engines from premature wear. Whether lack of lead in gas really causes valve damage in these engines is debatable.

In 1972, the Army and Postal Service drove a number of vehicles having heavy-duty "lead-required" engines on unleaded gasoline for over 100,000 miles. No accelerated valve damage was experienced in these engines.

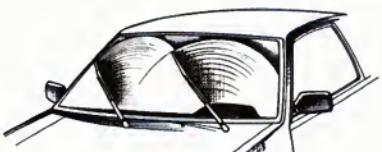
I'm not suggesting that based on this study you start using unleaded gas. But the good news for all who own older cars is that if leaded gas is to be phased out, it won't happen until the mid-1990s. Between then and now, if a law is passed, enough lead will be allowed in gas (at least 0.10 gram per gallon) to prevent possible valve damage. Richard Kozlowski of the EPA says the delay before a ban goes into effect will permit development of a substitute.

(Please turn to page 38)



Glass act

Whenever a set of wiper blades won't wipe clean, consider the possibility that oil and tar from the road, and industrial pollution in the air have settled on the windshield. This stubborn stuff clings to glass, but you may be able to wash it off with a mild detergent solution. If this doesn't work and a haze is left on the windshield, use Bon



OIL, TARS AND INDUSTRIAL POLLUTION ARE MAJOR CAUSES OF POOR WIPING ACTION

Ami. I've tried it, and it doesn't scratch glass as long as you don't press down too hard on the cleaning cloth or sponge.

Bill Dance,
top fishing pro and star of
"Bill Dance Outdoors" on TV.



NON-SLIP GRIP. FREE.

BUY NEW STREN® CLASS LINE AND GET A HANDY FISHING TOWEL.

Now you can get a better grip on a fishing record. With the Stren Season Opener Special.

Buy a reel-fill pak of new Stren Class Line between February 21, and March 16, 1985 and DuPont will send you a handy Stren fishing towel. Free.

It's high-quality cotton, thick and thirsty, complete with grommet and belt clip.

You can't beat the value, because you can't beat the

line. New Stren Class Line is designed to land record fish. We make it as strong as IGFA rules will allow.

So don't let the Season Opener Special slip through your hands. Look for the order form when you buy Stren Class Line. Or use this coupon. And clean up.

STREN FISHING TOWEL ORDER FORM.

MAIL TO: Stren Towel Offer, P.O. Box 3670, Lancaster, PA 17603

I HAVE ENCLOSED:

A original dated cash register receipt with purchase price circled

AND

The words "reel fill pak" clipped from a Stren Class Line package

NAME _____ AGE _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE () _____

PME03FT

I FISH:

5-14 days a year

mainly freshwater

15 days or more a year

mainly saltwater

Limit one Fishing Towel per customer

Offer good only on Stren Class Line purchased February 21 through March 16, 1985 in the U.S.A. Allow six to eight weeks for delivery. Subject to state and local regulations. Void where taxed, restricted or forbidden by law.

Request must be postmarked by March 16, 1985.



"New"

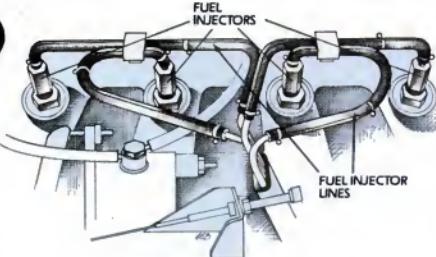


GM's oil policy: Part 3

The subject covered in your "Oil's well" item in the September '84 Car Clinic (page 20) is an important one that needs serious followup. GM dealers say they don't have SAE 5W-30 oil and never have had it even though temperatures well below 0 are common here in winter. The only people I find that market an oil near this is Sears, but it's an SAE 5W-40 oil. Neither the people at Sears or those at Buick's customer assistance department can tell me if it's recommended for my 1984 Skyhawk. Is the Sears' oil the answer?—Lee K. Miller, Bethel Park, Pa.

No, it is not.

In 20-plus years that *Car Clinic* has appeared in PM, no item has gotten more response than the one regarding GM's present oil policy. As Mr. Miller noted, it began with the "Oil's well" item. At that time, I said SAE 5W-30 is preferred for all GM four-cylinder engines and the 2.8-liter V6. I emphasized that using SAE 10W-40 in 1984 and 1985 models would void warranties of these cars and that SAE 10W-40 is not recommended for pre-1984 GM engines. GM contends that SAE 10W-40 may cause piston rings to stick, which



Diesel tips

Steve Denoo of Clay, N.Y., has a theory about diesel engines. It's this—

"After you live with a diesel, you get to know how to handle its little quirks." Steve's driven a 1981 Chevy Caprice Classic diesel 97,000 miles, so he knows. Here are two quirks he's been able to do something about:

■ Natural noise from the fuel injector lines: "Split rubber hoses, cut them to size and slip them over the lines. Keep the

hoses in place with a couple of small worm-drive clamps. This will quiet the sound considerably."

■ Warmed up engine doesn't start, although it cranks normally: "Clean the battery terminals. A warmed up diesel has to turn at a minimum 200 rpm to start. Even the slightest corrosion creates a voltage drop that prevents the starter motor from turning the flywheel at this speed."

leads to oil consumption.

In the January '85 *Car Clinic* (page 36), I followed up with another item on the subject. It presented comments from an automotive engineer who sug-

gested that GM's policy was a smoke screen—that there's more viscosity index (VI) improver in SAE 5W-30 than in SAE 10W-30—that the reason for the edit by GM was to meet Corporate

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ASK ABOUT SUPER VALUE DAYS AND NO MONTHLY PAYMENT FOR 90 DAYS*

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Average Fuel Economy (CAFE) requirements. VI improver leaves deposits that supposedly cause rings to stick.

Here's where the matter stands:

- If you own a 1984 or '85 GM car equipped with a gasoline engine, you *must* use an oil recommended in your owners' manual to prevent voiding of your warranty in case using another oil causes damage. Generally, this calls for SAE 5W-30 if you have a four-cylinder or 2.8-liter V6 engine and SAE 10W-30 for other engines.
- If you own a GM car equipped with a diesel engine—any year—you *must* use an oil having one of the following viscosity ratings to prevent voiding of your warranty: SAE 10W-30 for temperatures below 0 to 60°F., SAE 15W-40 for temperatures between 0 and 60°, SAE 30 for temperatures between 32° to over 100°.
- If you own a pre-1984 model with a gasoline engine and choose to use SAE 10W-40 (it's stated as acceptable in your owner's manual), you will not void the warranty. However, the possibility of piston ring sticking and subsequent oil consumption is greater.
- According to GM's Fuels and Lubricants Dept., there is more viscosity index improver in SAE 10W-40 than in other oils, even more than 5W-30:

"Relative to SAE 10W-30 engine oils.

SAE 10W-40 oils generally contain about 70 percent more VI improver. SAE 15W-40 oils contain about 25 percent more, and SAE 5W-30 about 40 percent more. Single-grade oils, such as SAE 30, generally do not contain a VI improver."

■ The more VI improver that an oil contains, the greater the buildup of deposits on piston ring lands. GM says, "The increased piston-ring-belt deposits expected in engines with SAE 10W-40 engine oils could lead to ring sticking and loss of oil control."

■ GM states that using SAE 5W-30 or SAE 10W-30 will increase fuel economy—"about 1 percent better."

■ What do you do if you can't get SAE 5W-30 oil? GM is making it available under the Mr. Goodwrench label. Your dealer can order it.

Until then, use one of the others. If sub-zero weather makes the engine harder to start because of it, you may have to buy a dipstick heater or some other engine-warming device.

Note: The information in this item applies only to GM.

PM

DO YOU HAVE A CAR PROBLEM?
Just ask Mort about it. Send your question to the Car Clinic. Popular Mechanics, 224 West 57th St., New York, N.Y. 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ Are you experiencing more than your share of alternator belt failures with a 1983-84 GM 2.5-liter engine? The belt may be hitting a bolt on the power steering pump bracket. Use a different belt (part No. 10034798).

■ Do you get a knocking noise for a few seconds after starting a cold 2.6-liter engine in a Chrysler vehicle? It might be caused by the timing chain tensioner relaxing too much. The condition won't harm the engine but, if the noise is annoying, it can be eliminated with a rubber spacer (part No. MD084945). Refer your dealer to technical service bulletin (TSB) 09-09-84.

■ EFI 1.6-liter engines in 1984 Ford Escort and Mercury Lynx may have a spark knock because of a worn distributor drive coupling. The trouble can be verified with a timing light. It will show itself as an erratic spark advance—as much as plus or minus 7°. If the drive coupling is worn, install a newly designed coupling (part No. E4KE12051B). Refer the dealer to TSB 84-20-10.

■ Oil leaks from around rocker arm covers of GM 2.8-liter V6 engines can be stopped by using a new composition gasket (part No. 14089252). Up to now, RTV sealer has been used. It hasn't worked. When installing the new gasket, apply a small amount of GM gasket sealer to the cylinder head-intake manifold split line and tighten rocker arm cover bolts to between 75 and 90 in.-lbs.



SNAPPER's patented Hi-Vac® system is like a giant industrial strength vacuum cleaner following you around. Your SNAPPER Hi-Vac® will pick up grass clippings, leaves, twigs, even pine straw. And it will leave your lawn looking clean all over.

A SNAPPER Hi-Vac® mower cuts cleaner, too. Because the unique high vacuum effect stands your grass up for a more uniform cut. Even when it's tall or damp.

The Hi-Vac® system is available on a wide range of SNAPPER walk mowers, lawn tractors and riding mowers. Moreover, it's only one of the many patented engineering features that continue to make SNAPPER the leader in lawn and garden equipment.

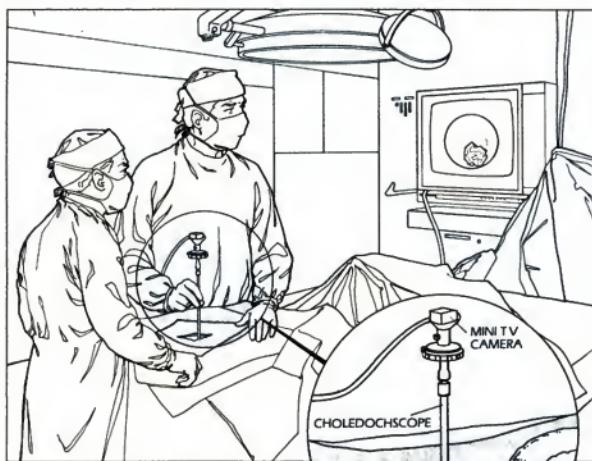
Because when it comes to quality, versatility and innovation, SNAPPERs are more than mere mowers. We pick up where others leave off.

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SCIENCE WORLDWIDE



Minicamera gives doctors in-sight



Surgical team examines remaining gallstone following operation using minicamera that weighs 1.6 ounces. Inset shows detail.

A surgeon's world is dark and mysterious. He works carefully, often unable to see where his scalpel is cutting. Lately, fiber optics have allowed the operating surgeon to see what he's doing. At last fall's Congress of the American College of Surgeons, Doctors George Berci and Alex Shulman of the California Cedars/Sinai Medical Center introduced a miniature fiberoptic camera. The 1.6-ounce camera is connected by fiberoptic cable to a computerized video monitor and a "choledochscope" that shines a tiny light in bile ducts so that the entire surgical team can look for dangerous tissue fragments.



Minicamera fits in surgeon's palm.

New pulsar is a sight for starry eyes

Pulsars are starlike objects that rotate about their axes at least hundreds of times per minute. They are believed to be neutron stars, far more massive than our sun but much smaller in volume. Until just a few months ago, only two pulsars had been observed in visible light. Both were in our galaxy. All other pulsars had been observed with X-ray sensing devices. But astronomers from Lawrence Berkeley Laboratory and Los Alamos National Laboratory now report

a visible pulsar in the Large Magellanic Cloud (LMC) outside our galaxy.

What's so great about the find? Studying the visible light will help scientists for the first time map out the motions of the pulsar as it wobbles wildly in place. How the light pulses tells them about "Starquakes", the shaking of what is believed to be a pulsar's hardened crust. Looking outside the galaxy will help develop general pulsar laws.

New biological spies

Doctors may soon be able to diagnose infectious diseases—polio, for example—even before symptoms appear. Workers at the Salk Institute have been experimenting with gene probes. These are chemical mixtures that mimic real genes. When injected into the body with a tiny amount of radioactive material, they pair up with the body's genetic material and form new radioactive genes that don't multiply or replicate again. Taking blood samples from patients injected with gene probes gives the doctors a glowing sample of the natural genes. Changes in the chemistry of those from the normal status reveals the presence of viruses. The technique may be tried outside the lab by the end of this decade.

Olympic police?

United States International University psychologist Donald Greene is using a technique developed for Olympic divers to teach SWAT team police how to relax before moving in on a violent scene. The relaxation keeps divers, and hopefully police officers, from injuring muscles in action. By breathing deeply three times and visualizing something positive before springing into action, he says injuries can be prevented.

A sound detergent

Throw out your bleach and get rid of the laundry soap. A Japanese research team at Nihon University has discovered that shooting ultrasound beams through a tub of water will stimulate oxidation which removes dirt from fabrics. Ultrasound in water is already used in some Japanese electronic labs to clean sensitive computer circuits. A Nihon spokesman tells our Tokyo correspondent that a prototype washing machine will be introduced in late 1985 or early 1986.

Also sprach Dickinson

Students studying German at Dickinson College in Pennsylvania talk directly to German students weekly via a new video satellite hookup. The first conversation held last fall was conducted entirely in German with the staff of the Bremerhaven Maritime Museum. Satellite hookups for other language students are contemplated next year. **PM**

CAMEL LIGHTS

It's a whole new world.



Today's
Camel Lights,
unexpectedly mild.

9 mg. "tar", 0.8 mg. nicotine av. per cigarette by FTC method.

Warning: The Surgeon General Has Determined
That Cigarette Smoking Is Dangerous to Your Health.

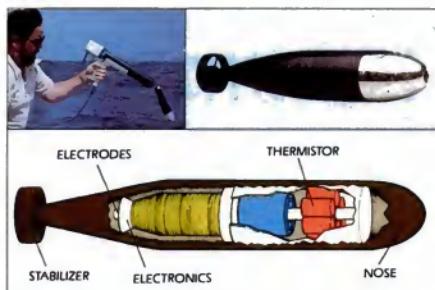
MARINE



New hovercraft replacing airliners

British Hovercraft's new AP-188 ferry has begun carrying 100 passengers per trip using new technologies that may keep a troubled airliner flying. Scandinavian Airlines System had watched its Copenhagen, Denmark to Malmö, Sweden, business dwindle from 200,000 passengers in 1972 to 40,000 in 1983. Last year, SAS instituted the Hovercraft Service across Øresund Sound, a 17-mile trip that takes 45 minutes. Breakthrough designs made the switchover possible. A new, low-pressure skirt design has increased payload capacity by over

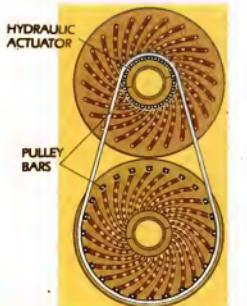
50 percent. Four new 450-hp Deutz diesel engines provide both lift and propulsion. Two provide power to four centrifugal lift fans and two drive the craft's flexed propulsion propellers. A pair of rotating bow thrusters help steer the vessel for quick entry into its docking facilities. Early reports are that SAS took over 100,000 passengers in 1984. SAS is considering designs for 150- and 200-passenger hovercraft.



It takes a fish to catch a fish

Hunting schools of oceangoing fish often involves bringing in big survey craft that drag water-testing devices behind them. Salt content and water temperature tell the fleets where to find the fish. It's an expensive proposition. But a new disposable depth probe developed by Sippican will eliminate those costs starting this summer. The torpedolike probe is fired from a handheld air gun. It drops into the ocean and broadcasts an electronic signal down to 200 feet. A thermistor measures temperatures as the torpedo submerges. A pair of electrodes measures salt content. The torpedo has a stabilizing rudder and hard aluminum nose. Its preprogrammed path of travel is fed to the stabilizer by a tiny microprocessor inside the nose. The Sippican probe was tested by the Office of Naval Research in 1982, and will search for lost or hidden submarines.

AUTOMOTIVE Smoothest transmission yet



Several European automakers have been experimenting with Continuous Variable Transmissions over the past two years.

The CVTs change a car's gearing in hundreds of steps rather than three, four or five as we are accustomed to have in autos. The problem with CVTs has been a slight lack of smoothness in the ride as the car gears up and down automatically. Designer Emerson L. Kumm says he has licked that and other problems with his new CVT. The Kumm CVT runs a flat Kevlar belt on two

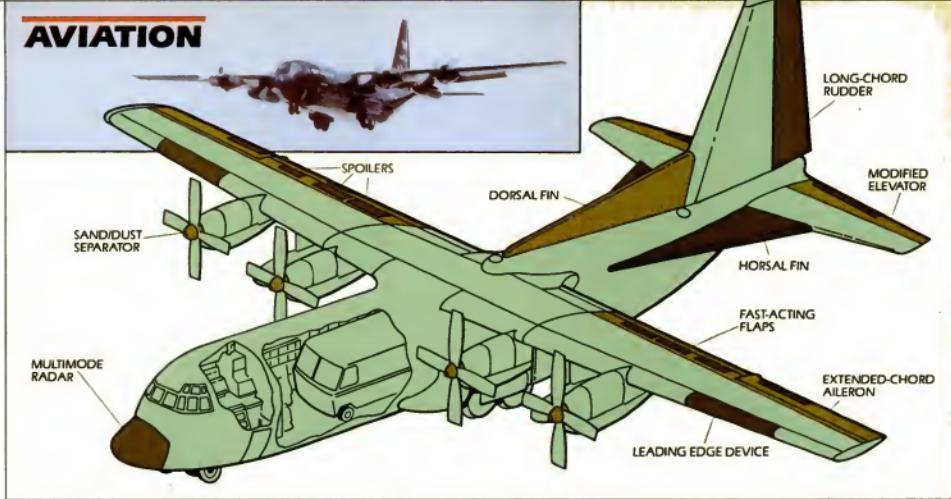
variable diameter pulleys. The diameter of one pulley decreases while that of the other increases, continuously changing the input-to-output speed ratio. The belt rides on a number of flat pulley bars that move in and out under the hydraulic actuator's power. The Kumm CVT may be in American cars by 1987.



Computer car

We test-drove the Buick Riviera CRT, which will be on the market in 1986. The car sports a computer screen that will eventually eliminate 80 buttons and dials on the dashboard. Powered by five computer modules, the CRT dashboard screen keeps controls in one place.

AVIATION



Flying aviation lab takes off . . . and up

From some angles, it looks like a stretched Lockheed Hercules craft. But when it banks in the sky, it looks like nothing you've ever seen before. It's the High Technology Test Bed, the aviation industry's latest answer to demands for military budget cuts. The plane carries on it parts that will be used on a half-dozen future planes. Dorsal and horral fins and a long-chord rudder are parts being tested for future Short Takeoff and Landing (STOL) craft. The extended chord ailerons are being tested for use in aircraft that will fly at extremely low altitudes. A

set of spoilers on the test bed may wind up on several different aircraft that will use them for roll and direct lift control.

New fast-acting flaps are being tested for use on jet fighters, and graphite sand/dust separators are being tested for small propeller-driven craft. Multimode radar in the test bed's nose will be incorporated into a wide range of future aircraft.

The test bed's fuselage carries a Mobile Data Center in a van. The MDC carries sophisticated computers to monitor the test bed's parts both in flight and as a ground monitor station.

MEDICAL

Technology has a heart

Two different artificial hearts were implanted in humans in 1984. Both may become obsolete by next year. Awaiting federal government approval is a new artificial heart called the Permanent Ventricular Assist System (PVAS). The implanted device consists of a pump, circuit board and battery pack. The entire affair weighs less than 3 pounds. Batteries, carried outside the body in a shoulder holster, weigh another 4 pounds.

The PVAS, built by Thermedics of Massachusetts, is rechargeable. "When you go to sleep, you simply plug yourself into a wall socket," explains Victor Poirier, senior

vice president of Thermedics. The pump, which is inserted in the patient's stomach cavity below the diaphragm, is made of metal and plastic titanium as well as Tecoflex, a new polyurethane material developed by Thermedics.

The new pump provides all the muscle power of a human heart but can work in connection with a severely damaged heart left in the patient. If it wins federal approval, the new pump could make artificial hearts widely available.



Artificial heart's parts (right) assist a damaged heart (left).



HI-FI sound

Doctors have long been using non-invasive sound waves to make sonogram pictures of fetuses in pregnant women. Now, British researchers have harnessed the technique to provide more than the traditional shadowy picture. By imposing computer images of previous sonograms, the British doctors can now follow the growth of the fetus to birth.

TECHNOLOGY UPDATE

SPACE



The big red space booster

The Soviet Union has completed construction of a new super-launch facility in Tyuratam, Russia, according to U.S. Defense Department officials. The massive facility will serve as launch site for the new Soviet space shuttle. But it also has a large launch pad to operate its answer to America's big Saturn and Titan rockets. The new Russian heavy-lift vehicle is believed to be about twice the size of America's largest rockets. It will carry as many as eight strap-on reusable boosters with a total liftoff thrust of 18 million pounds. That would be about 20 percent more liftoff power than American vehicles have. With the new heavy-lift vehicles, the Soviets will be able to carry 300,000 pounds of cargo into an orbit almost 400 miles above Earth—about the distance of our proposed space station to be built in the 1990s. The new Russian launch pad sits on a track system that allows the gantry to roll into position after the rocket is delivered. It allows for very quick launches. Russia is expected to launch several heavy-lifters over the next two years en route to launching its own space station.

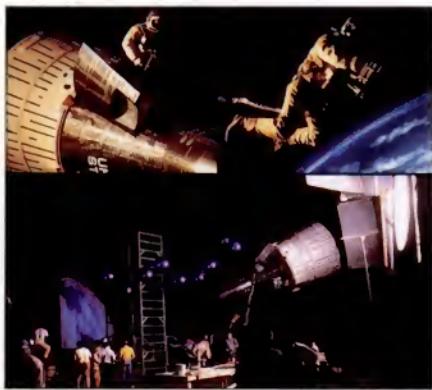
MODEL BY BRIAN SULLIVAN; PHOTO BY STEVE FAY

Editor: Dennis Eskow
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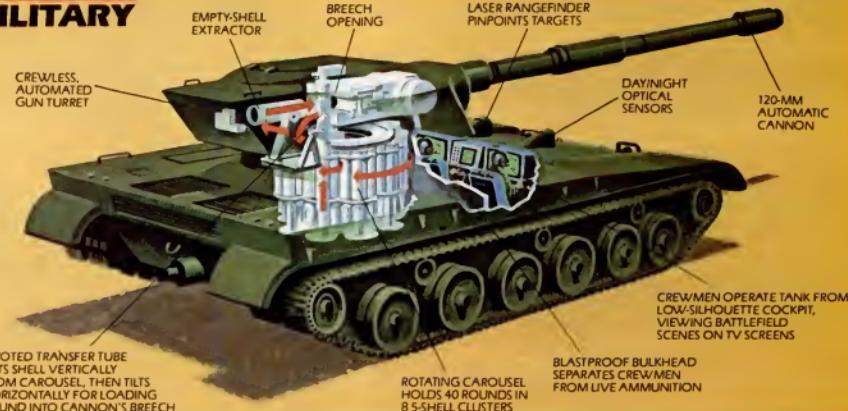
MOVIES

The toughest EVA yet

The official NASA terminology for a space walk is EVA, or Extra-Vehicular Activity. It's always a tough stunt to pull off in orbit, but it was even tougher to bring about for NBC's spring miniseries *Space*. The film, taken from James Michener's best-selling novel, includes a spectacular EVA scene in which two actors crawl out of a space capsule and hover in orbit above Earth. The film's special effects team used nine helium-filled balloons of 8 cubic feet each to give the astronauts' tethers a buoyant look. On the set, the capsule was raised about 15 feet off the floor and the astronauts suspended from nylon tethers hanging from overhead booms. The vertical tethers from which the stuntmen hung in body harnesses were made of a resilient fiber that gave them some bounce as they were swung slowly away from the capsule. The horizontal tethers that appear to hold them to the capsule were made of a slightly stiffened Kevlar. The balloons were so effective the stuntmen had to be pulled back into the camera frame several times while filming.



MILITARY



Tank of the future shoots fast, sees with TV eyes

Tomorrow's tanks will have a self-loading, rapid-fire cannon, a crewless gun turret and a control cab so exotic it resembles the cockpit of a modern fighter plane. These are just some of the sophisticated features being planned by the U.S. Army for next-generation battle tanks and other combat vehicles.

A self-loading cannon not only increases a tank's firing rate, but it eliminates the need for a manned turret, thus removing crewmen from a vulnerable position on top of the tank. This, in turn, permits a lower vehicle silhouette, making a tank harder to see and hit. The driver and commander sit low to the ground in the tank's bow, separated from all live ammunition by a heavy blast shield. Views of battlefield terrain, target-tracking plots, radar images and other vital maneuvering information are

displayed on TV screens in the cockpit so the crewmen are never directly exposed to enemy fire.

An ingenious autoloading system is already under development by FMC Corp. of Minneapolis. A motor-driven carousel holds 40 rounds of ammunition in eight five-shell clusters. Both the carousel and the individual clusters rotate independently so that all 40 rounds can be brought to the same location for loading. A pivoted transfer tube picks a shell from the carousel, flips it over, slides it sideways and rams it into the cannon's breech. After each firing, an extractor tube removes the empty shell casing while the transfer tube returns to the carousel for a fresh round. The reload sequence is so fast it can fire 120-mm rounds at the rate of one every five seconds.

Smart mortar can't miss

The old-fashioned mortar, a simple short-barreled cannon that dates back to World War I, might seem outmoded to some in this age of exotic weaponry. Not so, says British Aerospace.

The prominent aircraft and munitions maker has come up with a self-guided antitank projectile that could turn the lowly mortar into a deadly instrument of modern warfare. It's fired just like an ordinary

mortar round, but as it nears the end of its trajectory it automatically homes in on any enemy tank caught within its "footprint"—an area nearly 1,000 feet in diameter.

Called the Merlin Mortar Bomb, the projectile uses advanced millimeter-wave radar to seek out reflective metal targets in any weather, day or night. Its advantages lie in its simplicity. The new mortar shell can be fired from any standard 81-mm mortar without modifications, is easily handled by untrained infantrymen and is said to cost only a third as much as more sophisticated antitank missiles requiring skilled crews. Its steeply arched trajectory also assures a top surface strike where tank armor is the thinnest and most vulnerable.



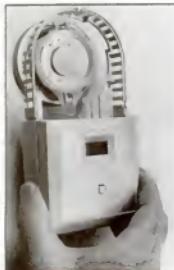
Spy in the sky

It's so small enemy radar can't tell it from a bird and it flies about so fast it's hard to shoot down. It's Britain's newest eye in the sky, a remote-controlled mini helicopter equipped with TV cameras and other sensors for spotting enemy targets. Called the Sprite, it's manufactured by ML Aviation Ltd.

Wireless home temperature control

First Alert has come out with a fully programmable, wireless home temperature control device. Called the Autostat, it offers the comfort, convenience and energy-savings of a programmable thermostat without having to replace your existing thermostat. The battery-operated Autostat works in conjunction with your thermostat to provide full setup/setback temperature control.

The microprocessor base unit can be programmed for four separate temperature settings during a 24-hour period.



Battery-operated Autostat mounts to the wall below existing thermostat. Motor-driven arm locks onto the ring attached to thermostat dial. Controls are behind panel [right].



Override button protrudes through panel to allow changing the temperature at any time without affecting the memory.

od. The pushbutton controls are concealed behind a drop-down front panel. A quartz clock displays the time of day and serves as a programming time-keeper. An override button allows you to adjust the temperature without affecting the program memory.

The Autostat comes in round and rectangular configurations to adapt to most home thermostats. They're about \$50 in home centers and hardware stores. Contact BRK Electronics.

Pittway Corp., Marketing Dept., 780, McClure Rd., Aurora, Ill. 60504.

Self-cleaning water heater

You may never again have to drain your water heater to remove sediment. The Reliance Sta-Kleen water heater has a self-cleaning system that prevents particles of sediment from settling on the tank bottom. Cold water enters through angled ports which create a vortex in the tank. Particles are swept up and held in the turbulence, then carried out by the heated water.

Sta-Kleen heaters are available at home centers and hardware stores in different capacities in both gas and electric models. A 40-gallon gas heater costs \$229; the same size electric unit costs \$218. For details, contact Reliance Water Heater Co., Cumberland St., Ashland City, Tenn. 37015.



Turbulence sweeps up and removes sediment [left]. Models: electric [center] and gas [right].

Powerful air purifier



You can reduce air pollution in your home and office with a King-Aire air purifier. A supersensitive three-stage filtering system removes dust, germs, pollen, mold, smoke, gases, odors and chemical pollutants from the air and then exhausts 99.97 percent pure air, according to the manufacturer.

The Century model (\$700) has an actual air-flow velocity of 150 cu. ft. per minute (cfpm). The Guardian purifier (\$900), shown, has an actual airflow velocity rating of 270 cfm. Both units feature hardwood oak cabinets.

Write to King-Aire Inc., Box 149-PM, Carmel, Ind. 46032.

Masonry waterproofer

Here's a new product to seal masonry walls to hold back water and to prevent moisture seepage. Drylok masonry waterproofer is a ready-mixed liquid that can be applied with a brush, roller or sprayer. It works on surfaces below and above the ground, inside or out. Drylok can withstand water pressure up to 4 psi. It also repels rain from concrete retaining walls and stucco.

Drylok is at hardware stores and home centers for about \$17 per gallon in white, green, gray and beige.

Write to Drylok, UGL, Box 70, Dept. PM, Scranton, Pa. 18501.



FM



There's a lot to appreciate behind the wheel of a new Grand Prix. While its finely detailed interior harbors you in private luxury, its brightly accented exterior invites longing glances.

But it's out on the open road that Grand Prix really shines! Feel the power of its responsive 3.8 liter V-6 engine or the available 5.0 liter V-8. Either way, Grand Prix comes standard with an automatic transmission.

*Aren't you
glad we use dials?
Don't you wish
everyone did?*

Enjoy the control of its power steering and power brakes, and ride on the sure-footed comfort of its full coil suspension.

But there's one more thing we're sure you'll appreciate: the available Rally gage instrument panel with tachometer that

keeps you dialed in to many of Grand Prix's most vital systems. Grand Prix... undeniably Pontiac!

*Courtesy of Armour Dial, Inc.  

PONTIAC GRAND PRIX

WE BUILD EXCITEMENT

COOL IT.

TURBO

New Ultra-tech Turbo Formula P-Z-L, for longer life in the fast lane.

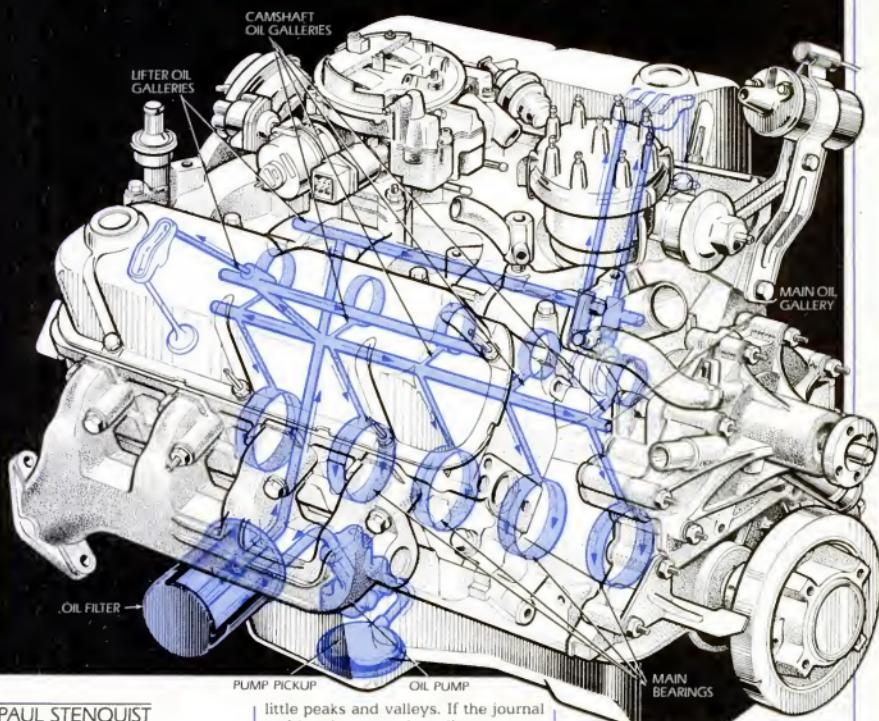
Turbos are intense. They work hard, run hot. So do you. That's why you got a turbo. That's why we've got Turbo Formula P-Z-L. Because when you're hot, it's not.

While you're burning up the fast lane, protect your working parts with Pennzoil. We know you're a limit-tester. So we exceeded the limit, created a turbo formula that is above the standards of the American Petroleum Institute, that surpasses every automotive manufacturer's requirements anywhere in the world. We took it to the wall, and then some. We went beyond spec. We went ultra-tech.

So cool it with Pennzoil's Turbo Formula P-Z-L. When you're hot, it's not.



SOLVING OIL PRESSURE PROBLEMS



BY PAUL STENQUIST

The first thing you notice might be the soft glow of an idiot light when your engine is idling. Or perhaps the needle of your oil pressure gauge has begun to drop out of the safe range. Or maybe you've just noticed that your engine ticks and clatters much more than it used to. They're all clues that could point to an oil pressure problem. If you don't act right away, extensive engine damage can result.

A magnified view of an engine's crankshaft journal and bearing surfaces makes it very easy to understand why a loss of lubricant can be so critical. Although these surfaces appear completely smooth to the naked eye, they're actually covered with

little peaks and valleys. If the journal and bearing come into direct contact at high speed, the resulting friction quickly generates heat that can cause the metal parts to seize.

On the other hand, if these moving parts are separated by a film of lubricant, the sliding friction is replaced by fluid friction. Because the molecules of the lubricant move freely when they encounter high or low spots on the machined parts, they offer little resistance to movement. Consequently, heat generation is minimized, protecting the surfaces.

Delivering the lube

Modern automobile engines are equipped with a full-force lubrication system that pumps oil to most moving

Modern engines have pressure-fed lubrication systems that are supplied with filtered oil by a mechanical pump.

parts (lead illustration). Oil is drawn into a pump through a mesh screen submerged in the oil pan.

In most systems, the pressurized oil is first pumped through the filter. The filter or filter mount is equipped with a bypass valve so flow will not be interrupted if the filter clogs.

The filtered oil is then pumped into the main oil gallery. Oil is usually supplied to hydraulic lifters and main bearings by means of passages connected to this gallery. Oil routed to the lifters is then directed up to the rest of the valvetrain, via a separate passage

or through the pushrods. Main bearing lube travels through drilled passages in the crankshaft journals to the connecting rod bearings. Oil spray from between the connecting rod pairs, or in some cases, from a small passage in one side of each rod cap, lubricates the cylinder walls and piston pins.

Low oil pressure is the result of problems in the pump or delivery circuit. If the pump can't supply enough oil to fill the galleries, pressure will be low. If there is an overly large opening in the circuit that allows oil to escape too easily, low oil pressure will result. Improper oil viscosity or oil dilution can also make pressure readings drop below spec, as pump efficiency is dramatically affected by the thickness of the lube.

Checking oil pressure

If you feel that your engine's oil pressure is lower than it should be, you can confirm your suspicions with a remote gauge.

Purchase a mechanical-type oil pressure gauge and installation kit from an auto parts store (Fig. 1). The installation kit will include a number of pipe fitting adapters, one of which can be installed in your engine in place of the idiot light switch. If your car already has an oil pressure gauge, install the adapter in place of the stock gauge sending unit. The pressure test will confirm the low reading of your stock gauge.

Manufacturers' specifications for oil pressure vary. To be absolutely sure that your engine's lube system is operating reasonably close to full capacity, you should check oil pressure test specs for your car in a general service manual or in the vehicle manufacturer's manual.

Generally, two figures are given, one for idle oil pressure and one for 2,000-rpm pressure. In most cases, your pump should be able to provide about 10 psi at idle with a fully warmed engine and 25 psi or more at 2,000 rpm. Some makers, however, call for considerably more pressure.

If your test finds that oil pressure is okay but the idiot light continues to glow, replace the oil warning light switch. If a new switch doesn't turn the light off, check the oil light switch circuit for problems.

Solving low-pressure problems

If you found that oil pressure was below the recommended figure at idle but within the acceptable range at higher speeds, check the engine idle

speed. It may be below specs.

Oil pressure that is somewhat low at one or both test points can be caused by motor oil that is of incorrect viscosity or has been diluted with gasoline. Try an oil change, using the manufacturer's recommended oil viscosity for the weather conditions.

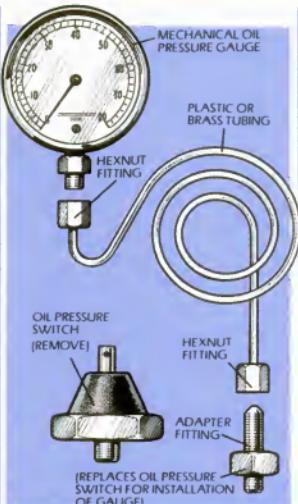
If the oil change solves your pressure problems and you find that the drained oil is heavily diluted with gasoline, find the cause of the dilution before putting the car back in service. It may have been caused by an engine misfire that allowed unburned fuel to run down past the rings, or, on carbureted cars, it may be the result of a ruptured fuel pump diaphragm.

A clogged oil filter can also cause a loss of pressure. If your filter has been on the car for more than a few thousand miles, change it and retest.

Pulling the oil pan

Having eliminated simple causes, further diagnosis requires removal of the oil pan on most powerplants (Fig. 2). On some engines, however, the oil pump is externally mounted and can be checked without removing the pan. If this is the case on your engine, proceed to the section headed "Checking the oil pump."

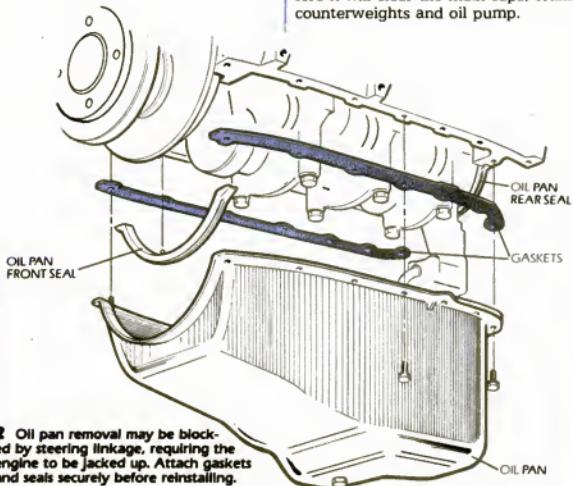
On some cars, oil pan removal is a simple task but on most it is quite difficult and may involve loosening the engine mounts and jacking or lifting the engine. The starter motor or other components may have to be



- 1 To read the actual engine oil pressure, install a mechanical gauge in place of the stock idiot light or indicator.

removed to get to the pan bolts.

Specific instructions for oil pan removal are found in both general service manuals and vehicle manufacturer manuals. On some "short skirt" type engines, the pan will have to be dropped more than a few inches before it will clear the main caps, crank counterweights and oil pump.



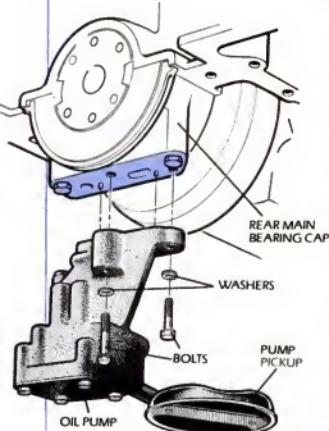
- 2 Oil pan removal may be blocked by steering linkage, requiring the engine to be jacked up. Attach gaskets and seals securely before reinstalling.

Checking the oil pump

If your engine suffered a total loss of oil pressure, the cause is most likely a broken oil pump drive.

Most oil pumps are driven by a shaft that joins the pump to the distributor drive gear or by an intermediate shaft that is fitted with a gear and driven by the cam. If the drive mechanism breaks, a total loss of oil pressure will be the result. Another possible cause of total oil pressure loss is a missing oil gallery plug.

In addition to the simple causes mentioned previously, partial loss of pressure can be the result of a worn pump, a clogged pump pickup, a hole in the pickup tube or broken tube or excessive bearing clearance. Less likely causes for partial loss of pressure include leaking gallery plugs and porous block castings.



3 Most oil pumps are located inside the pan, bolted to a main bearing cap. Torque to correct spec when reinstalling.

Since you have to remove the oil pan on most engines to check any of the more likely causes, you ought to check all of them before buttoning up. On high-mileage engines, low pressure is frequently caused by a combination of pump and bearing wear.

Once the pan is off, remove the pump from the engine. It's held in place on the block or on a main bearing cap by one or more bolts (Fig. 3). In most cases, the pickup tube is attached only to the pump, although on some engines it may be retained by a bolt. On engines with external pumps, the pickup is usually bolted to

4 On spur-gear type pumps, critical clearances to be checked are those between the gear edge and housing, and between gear ends and the bottom plate of the pump.

a machined surface inside the crankcase.

If the pickup tube is pressed into the pump, leave it in place. If it's pinned or bolted to the pump, remove it for inspection. Examine the pickup and pickup tube for possible air leaks. Check also if there is clogging of the pickup screen.

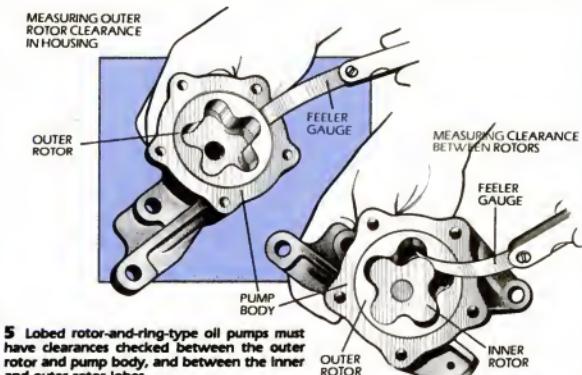
Disassemble the oil pump by removing its bottom cover. Hold the pump in a vise between two pieces of wood or brass jaws. On some engines that have externally mounted pumps, the cover (as well as the gears and relief valve) can be removed without unbolting the pump from the engine.

On the pump cover or body, you'll probably find a hexhead or expansion cup plug. The pump relief valve and spring are installed behind this plug. Remove the plug, valve and spring, and check to see how the valve moves in its bore. If you find that it is stuck in its bore or fits so loosely that you can move it sideways any discernible

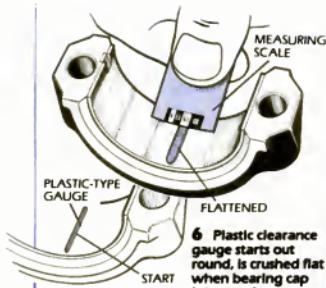
amount, it could be the problem. Replace the valve and the pump or cover as necessary.

If your oil-pressure test found that pressure was okay at idle but lower than specified at a higher speed, a weak relief valve spring might be the source of your trouble. Some manufacturers provide a specification for relief valve spring length. (A weak spring will be shorter than a good

MEASURING OUTER ROTOR CLEARANCE IN HOUSING



5 Lobed rotor-and-ring-type oil pumps must have clearances checked between the outer rotor and pump body, and between the inner and outer rotor lobes.



6 Plastic clearance gauge starts out round, is crushed flat when bearing cap is torqued.

one.) Measure your spring and compare it to spec.

Under the pump cover, you'll find the pumping mechanism. Two types are commonly used. One utilizes a driven, lobed inner rotor that turns a surrounding lobed ring or outer rotor. The other variety uses two spur-type gears, one of which is attached to the drive shaft.

Inspect the gears, pump cover and pump body for signs of wear and scoring. Obvious damage is grounds for replacement. If you're in doubt about pump condition check clearances with a feeler gauge.

To check spur-gear type pump, measure clearance between the top of the gears and the pump body's gasket surface using a straightedge (small steel ruler) and a feeler gauge (Fig. 4). Lay the edge of the rule across the gasket surface and insert the feeler gauge between it and the gears. You'll find specifications in a service manual. Using a narrow feeler gauge, check clearance between the edge of the pump gear and the pump body.

If your car is equipped with a lobed rotor-and-ring-type pump, you should at least check clearance between the center rotor and the pump body gasket surface, between the outer rotor and case, and between the inner rotor lobes and outer rotor lobes (Fig. 5). Chrysler also provides specs for checks of cover flatness, rotor thickness and outer rotor diameter.

Measure clearance between the center rotor and gasket surface with a straight edge and rule. Check clearance between the high points of the two rotors and between the outer rotor and the pump body with a feeler gauge. For the 2.2-liter Chrysler, the specs are .01 in. (maximum) and .014 in. (maximum), respectively.

Check cover flatness with a rule and feeler gauge, laying the side of the rule across the center of the cover and

inserting the feeler gauge into any low spots below it. If the pump is not up to spec, it must be replaced.

Before reinstalling a spur-gear type pump, pack the gear cavity tightly with petroleum jelly. Fill lobe and ring type pumps with motor oil.

Checking bearing clearance

As bearing clearance gradually increases due to normal wear, the lube oil escapes more easily from the force-fed circuit and pressure drops. Because some of the lube escapes prematurely, certain parts don't get enough. If main bearing clearance, for example, is excessive, the rod bearing oil supply will be inadequate.

The bearing clearances of an assembled engine can be checked using a plastic gauging material (Fig. 6). This product, which is best known by Perfect Circle's trade name Plasti-gage, will provide accurate measurement of bearing oil clearance when it's crushed between the bearing and the crankshaft (Perfect Circle, Dana Corp., P.O. Box 455, Toledo, Ohio, 43692). Purchase two different sizes of the material at an auto parts store so you can measure clearances from .002 in. to .006 in.

To check main-bearing clearance, remove main caps two and four (on five-main-bearing engines) or two, four and six (on seven-main-bearing engines). Insert paper shims that are at least .010 in. thick between these bearings and the crank and reinstall the caps. This will lift the crank off of the other bearings to check clearance.

Remove each of the other bearing caps one at a time and wipe all oil from journal and bearing. Then, place a piece of the gauging material on the center of the bearing in such a way that it spans the width of the bearing. Install the cap, torque it to spec and remove it without turning the crank. Now, compare the crushed strip of gauging material to the scale on the package. This will give you the clearance figure.

If the strip is so wide that it's off the scale, or if it hasn't been flattened at all, use a different size gauging strip to get an accurate reading.

Check clearance of the other main bearings in the same way. Then, move your paper shims to journals one and five or one and seven and check the clearance of the bearings which previously supported the shims. Record all the numbers on a piece of paper, along with the part numbers and any size indication on the bearings (Fig. 7).

Check rod bearing clearance in a

similar manner. Remove rod caps one at a time. Place the gauging strip on the rod cap bearing and reinstall, torquing to spec.

If you have a micrometer, check the rod throws for taper and out-of-round by measuring each throw at both ends and at points on the circumference that are 90° apart.

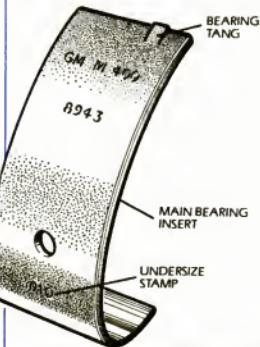
Compare your figures to manufacturer's specs. If rod journal taper or out-of-round are in excess of what the manufacturer allows, the engine will have to be rebuilt.

However, if the crankshaft is otherwise okay, but clearance is in excess of manufacturer's allowance, you can probably tighten it up by replacing the bearings with "undersize" bearings. (Undersize bearings are actually larger than standard; they're called undersize because they're for use with undersize cranks).

For most applications, bearings are sold in standard as well as .010- and .020-in. undersize. In each of these sizes, bearings can be purchased with an additional .001-in. or .002-in. undersize. The extra bearing material makes up for too much clearance.

Determine which bearings you need by calculating how much the present clearance exceeds ideal specified tolerances. Go to the parts store armed with bearing part numbers and any undersize indication that may have been found on the back of the bearings. A knowledgeable counterman will have no trouble helping you choose the proper replacements for your crankshaft's bearings.

After installing the new bearings, check all clearances again. Check all rod and main bolt torque readings twice, and reinstall the oil pan. **FM**



7 Back side of the bearing insert is stamped to indicate undersize dimension.



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HOW TO INSTALL REPLACEMENT CELLAR DOORS

Discover a do-it-yourself cellar door system that will work on any home.

BY JOSEPH TRUINI
Shop And Tools Editor

Old, deteriorated wood cellar doors are more than just an eyesore. They're unsafe, provide little security and are major energy-wasters. Now there's a do-it-yourself steel replacement door system that, with the use of foundation plates, will work on any home regardless of the condition or size of the existing entryway foundation.

Foundation plates are simply L-shaped sheet-metal pieces that are screwed to the foundation before attaching the door frame. The plates allow you to modify an existing entryway to accept standard-size doors. Many older homes have entryway foundations that are too wide, narrow, long or short to accept standard cellar doors. But, the use of foundation plates solves these problem installations.

Foundation plates also provide a sound, flat surface for mounting doors on rough, irregular foundations built of granite, fieldstone, brick, concrete block or poured concrete. The L-shaped plates wrap around the outside corner of the foundation to provide a weather-tight seal that protects against rain and wind.

Cellar doors come in two basic styles: with steel sidewalls for installation on flat foundations, and replacement doors for use on entryways with raised foundation sidewalls. In the installation shown, we set foundation plates and replacement doors on a raised sidewall. The cellar door system we installed is

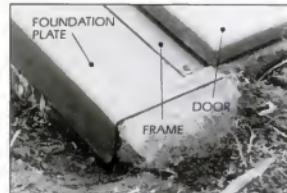
(Please turn to page 56)



Replace old, rotting wood doors (right) with secure, energy-efficient steel replacement doors (above).



After removing the old doors, fasten the foundation plates to the foundation. Be sure side plates overlap the base plate.



Close-up view shows how the foundation plate wraps around the outside corner of the foundation to seal out wind and rain.



Mount the assembled door frame to the foundation plates with self-tapping screws. Then, apply silicone caulk between the frame and plates to form a weather-tight seal.

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*Use these figures for comparison. Your results may differ. CA figures lower.

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ONLY IN A JEEP **CHEROKEE**

REPLACE CELLAR DOORS

(Continued from page 54)

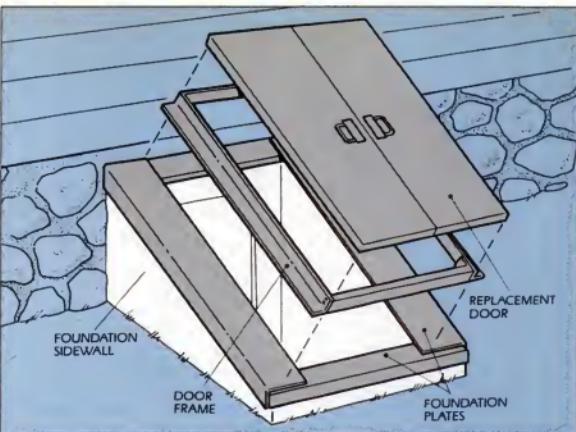
manufactured by Gordon Door Corp., 170 Spring St., Southington, Conn. 06489. Write to Gordon Corp. for additional information regarding cellar door installation, prices, availability and ordering procedures.

The first step is to remove the old wood doors and the wood base plates on which the doors are mounted. Be careful not to damage the siding when removing the existing header from the house. Next, inspect the foundation for loose bricks, blocks or crumbling or severely cracked concrete.

Repair any serious structural faults that will affect the foundation strength. This is also a good time to make any necessary repairs to the exterior of the sidewalls and to the steps leading down to the basement.

Next, install the foundation plates. Foundation plates come in 7-ft. lengths ranging in size from 3×5 in. to 3×14 in. The 3-in. dimension is the short leg of the L-shaped plate which wraps around the outside corner of the foundation. Plates can also be special-ordered from Gordon Corp. to any size for custom installation.

First, cut the base plate—the bottom piece— $\frac{1}{4}$ in. longer than the outside width of the entryway foundation. Use a hacksaw or a circular saw fitted with a metal-cutting blade. Then, cut the side plates the same length as the foundation sidewalls. For appearance sake, make the cuts on the ends that go against the house. Now, position the plates on the foundation with the side plates overlapping the base plate. Drill screw mounting holes through the plates and then continue the holes into the foundation using a masonry bit. Fasten the plates with lead anchors and sheet-metal screws or lag screws.



Shown here is a typical replacement door installation on a raised sidewall. Foundation plates are necessary to modify the foundation to accept standard-size doors.

Next, assemble the door frame on the ground using the bolts provided. Be sure that the bolt heads face the outside of the frame. Then, position the assembled door frame on the foundation plates. Bolt the header angle (top cross plate) to the door frame header and then screw the header angle to the house itself.

Now, slide the doors onto the frame. Adjust the frame from side to side until the doors fit squarely and will open and close without binding. Then, drill through the door frame and foundation plates to accept $\frac{3}{16}$ -in.-dia. self-tapping hexhead screws.

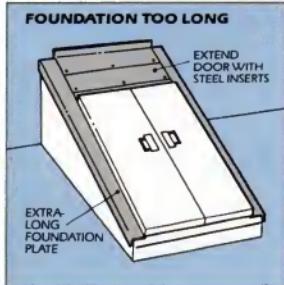
Next, to ensure a weatherproof seal, apply silicon caulk where the door frame flange meets the plates. Then, use fresh cement to fill gaping holes

and cracks on the interior of the entryway where the L-shaped plates sit on top of the foundation.

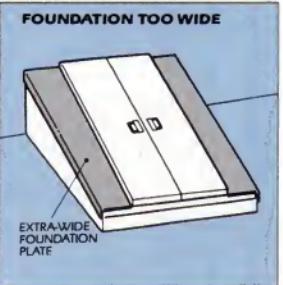
The foundation plates and doors come sprayed with a coat of primer paint. But, to ensure maximum protection against rust and corrosion, apply two coats of an alkyd enamel paint immediately after the installation is completed. Then, repaint the doors and plates every two to four years depending upon the amount of use and exposure to harsh weather.

Other attractive features of this cellar door system include stainless-steel hinges, hot-dipped galvanized sill, tamper-proof bolt lock, catch rods that lock the doors in the open position and recessed water channels to ensure proper drainage.

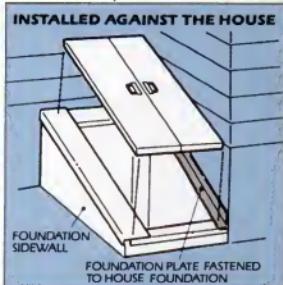
Foundation Plates Solve Problem Installations



When an entryway foundation is too long for standard-size doors, use long foundation plates and steel inserts to fill the space. Attach inserts to the door frame.



If the entryway foundation is too wide to accommodate standard-size doors, then use extra-wide foundation plates to close the entryway enough to accept the doors.



Some cellar entryways butt against the house foundation and have only one raised sidewall. Install a foundation plate to the wall to support the frame and doors.



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 **INTERSTATE
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Set Up Your Computer System With HITCH-FREE HOOK-UPS

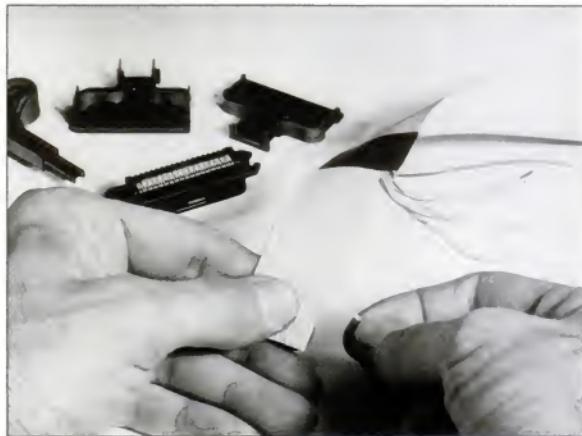
Connector cables for your printer and modem can cost a bundle. Here's how to make your own.

BY WALTER SALM

You need connecting cables so your computer can talk to its peripherals. The price tag on these cables often induces sticker-shock in first-time computer buyers. A typical 10-ft. connector cable that marries an IBM-type computer to a parallel printer might cost you nearly \$50 ready-made. You can make it for about half the price. Even from the most expensive part source, ribbon cable (at 69 cents a foot) will cost you \$6.90, a male, 25-pin D-type connector goes for \$7.75 and a 36-pin Centronics connector of the same gender runs \$8.95. Your total: \$23.60.

Degrees of difficulty

Building a cable set from flat ribbon is child's play if you're making a straight-through hookup, where the pin numbers from one connector go to the same numbers on another. This occurs when you're mating compatible components—say, D-type to D-type (a 25-pin "serial" connection for communications modems and some printers) or Centronics-type to Centronics (a 36-pin "parallel"



When separating conductors place piece of tape 2 1/2 in. from the end to prevent peeling.

connection for printers). Unfortunately, not all cables are this simple. A good example is the aforementioned \$50 cable used to connect popular IBM-type computers to aftermarket printers of many brands.

One end of that cable requires a D-type connector to match the 25-pin output of IBM computers, while the other end needs a 36-pin connector to fit the Centronics-type input now stan-

dard on most aftermarket printers. In this case, you have to study the technical manuals to determine which pin numbers match up at each end. PM's done the homework for you: The pin matching sequence for the IBM parallel is diagrammed at left.

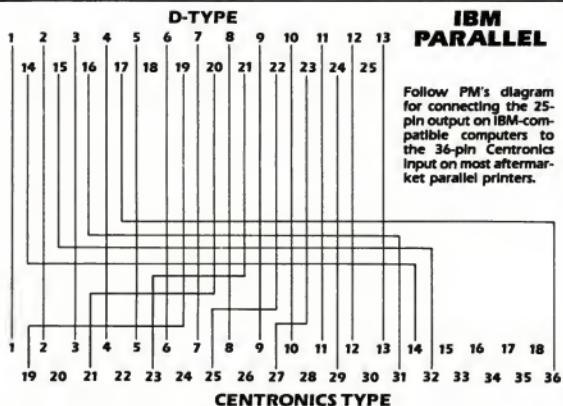
Before you buy parts for your cable, check your computer equipment to determine whether female or male connectors are required (male connectors have multiple pins; females have a series of holes into which the pins are inserted). Also, buy 25-conductor flat-ribbon cables for D-type connections, 36-conductor for Centronics connections and 25-conductor for D-type to Centronics hookups.

Simple connections

Straight-through flat ribbon cable connectors from companies like AMP and 3M require just one tool for assembly—a bench vise. The connectors contain two rows of V-shaped, fingerlike contacts. Each one of these contacts grabs its own wire and holds it separately from the adjacent wire in the ribbon cable.

The 3M connectors come with double-sided adhesive on the back piece (the part that pushes the cable into those V-shaped contacts) to help you position the ribbon cable before clamping the two halves together. This is a

(Please turn to page 62)





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Your suspension system has springs, spring shackles, control arms, stabilizer bars, bushings, shock absorbers and, sometimes, MacPherson struts. It's not simply shocks.

So if your car isn't handling right—or riding right—don't just assume it needs shocks.

It's better to let an expert technician make the diagnosis.

GET A MR. GOODWRENCH SUSPENSION CHECKUP

See Mr. Goodwrench for a Suspension Checkup. He has GM Training. And he has the right tools and high-tech equipment to do his job right.

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A stop motion camera catches the action as the wheel hits a pothole. The suspension system absorbs the jolt.



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*Lifetime limited warranty for as long as you own your GM vehicle on which replacement shocks were installed. See GM dealer for details.



wrench

LET'S GET IT TOGETHER...BUCKLE UP.



HITCH-FREE HOOK-UPS

(Continued from page 58)

nice feature, which helps to keep the cable straight and in position.

The AMP connectors have enough space to feed the ribbon cable through when the back piece has been started—again letting you keep the ribbon in a precise position. Once you have the ribbon positioned and the two halves of the connector in place, hold it so the cable doesn't slip, put it between the jaws of a bench vise and tighten the vise until the back piece snaps into place and can go no farther. For either brand of

connector, simply repeat the process at the other end of the cable—and don't overtighten the vise: You might damage the connector.

Whenever you start one of these cable sets, find pin 1 on the connector, and mark the No. 1 pin corner on the back of the connector with a red crayon so you can find it later. Most ribbon cables are gray except for a stripe of red ink down one edge. Put the red-striped edge into pin 1, and do the same at the other end. Some ribbon cable is rainbow-hued, with repeating sets of 10 different-colored wires—starting with brown. Brown is your No. 1 pin wire.

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Or write Husqvarna, 224 Thorndale Avenue, Bensenville, Illinois 60106.

Many connectors label only pin 1; you have to figure out the others for yourself. Some connectors will have the four corner pin number labeled; sometimes all the pins are numbered. And you'll find some connectors that have no pin numbers at all.

Remember that male and female pin numbers are mirror images of each other, and they're mirror-reversed once again when you go from front to back of the connector.

Discrete wiring

Besides squeezing the ribbon cable in a vise, there are three other ways to attach the wires to the connector. All of them take more work and much more time. These other methods use discrete wiring—connecting the conductors one by one—so use this type of connector only when you must change pin connections (as when mating D-type to Centronics connectors), or when you absolutely can't get the straight-through, flat-ribbon cable connectors.

At some parts-supply stores, you'll find that the connector supply consists almost entirely of D-types with solder-cup back lugs. Trouble is, flat-ribbon cable wires are super-skinny (22 to 28 gauge), and these connectors don't provide a convenient anchor point to bend the wire around. You have to strip the wire, tin the end, fill the connector pin cup with solder and slip the wire in. Hold the wire until the solder cools and locks it in place. You're working in close

(Please turn to page 140)



T-handle tool helps push separated wire conductors into the V-shaped slots in AMP brand connector. For 28-gauge wire, use color-coded connector with yellow dot.



With 3M brand connector, attach flat ribbon cable to adhesive surface of back piece (top) before assembly.

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PRUNING TOOLS



HERE ARE FIVE THAT'LL DO IT ALL.

Thinning or cutting back the plants on your property is a critical maintenance job for several reasons. First, careful pruning maintains the attractive shape of bushes, hedges and other plants. Second, pruning plants helps keep them strong and virile so they can support and increase production of fruit or flowers. Third, cutting back plants near your house increases the safety and enjoyment of your home. Pruning dead and damaged limbs that are prone to fall protects your house against possible dam-

age. And, reducing the growth of plants near your house allows sunlight to enter indoors.

Following are five types of pruning implements, with suggestions for their use and how to sharpen them. These tools should be able to handle all of your pruning needs.

When making your purchase, buy the best tool that you can afford. A good quality tool is designed to make clean cuts, work easily and comfortably, be long-lasting and stay sharper longer.—P.S.



PRUNING SHEARS

There are two basic designs in hand pruning shears: anvil and blade, and hook and curved blade pruners. Both are used for light pruning, to

cut stems and small branches up to 1/2-in. in diameter. When purchasing pruning shears, look for one that feels comfortable in your hand and provides accurate control. Check also for a positive and easy-acting locking mechanism so you can carry the closed tool safely in your pocket. [\(Please turn to page 66\)](#)



Hook and blade pruner

A hook and curved blade pruner cuts in a scissors action. It is shown here being used to prune crossed branches on a peach tree. The hooked blade holds the branch in position as the curved blade cuts it. This one-hand pruner also is called a bypass pruner, since the blade passes alongside the hook when cutting.

The Super-Pro D-Grip model shown (\$26.90 postpaid) has blades machined to within a 2-micron degree of accuracy (1 micron equals .0003936 in.). Blades are hard-

ened and tempered to a high level to maintain a sharp edge. The cutting blade is coated with DuPont's Teflon-S to resist rust and gumming and to decrease friction. Synthetic rubber strips on the handles help you grip the tool firmly and cut accurately.

The Super-Pro D-Grip bypass pruner has stainless-steel springs, a positive, twist-action lock and a hand strap. The tool is from Nippon America Inc., Sabotin Fine Garden Tools, 20 Backus Ave., Box 1262, Danbury, Conn. 06810.



Anvil pruner

The anvil pruner cuts with a straight blade pressed against a blunt anvil. This True Temper AP 4 [about \$12] has an adjustable tension control that you can set depending on the cutting power needed and your strength. It also features a replaceable precision-ground steel blade and a replaceable coated metal anvil. The company recommends that the tool be sharpened by a professional sharpener, since the blade must make exact contact with the anvil. The pruner is available at lawn and garden stores from True Temper, Shiremanstown, Pa. 17011.



The pruner can be disassembled for sharpening. For best results, try to maintain the factory bevel and use a white ceramic stick or a ceramic-coated stick as shown. These sharpeners are sold at cutlery stores.



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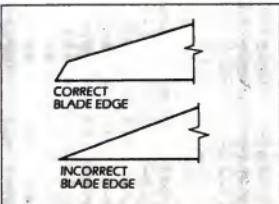
LOPPING SHEARS



The Corona 126 BN lopping shears [about \$37] have 26-in. handles and a head of forged steel. Here, the lopper reaches down to prune root shoots under a quince tree. It's made by Corona Clipper Co., Box 1388, Corona, Calif. 91720-0876.

(Continued from page 64)

Due to their two-hand action and long handles, lopping shears have greater cutting strength and give the user a greater reach than the one-hand pruners. Lopping shears help cut larger branches, vines or small tree limbs from $\frac{1}{2}$ in. up to 2 in. in diameter. The most popular type of lopping shears is the hook and curved blade design. Shears come with handles 19 to 32 in. long. Buy shears with good spring action and a rubber bumper between the handles just under the jaws.



The lopping shears shown are hollow ground, thus proper sharpening is important to avoid damage. Use a 6-in. mill, smooth, single-cut file. Maintain the factory bevel on the cutting edge, as shown, in the top drawing at left. Start from the back stroking toward the point in one continuous motion. The hook requires little maintenance during the life of the tool. Cleaning and lubrication after use prevents sticking and rust. Never file or grind the flat side of the blade; it's a job for a professional. Use the file on the flat side only to remove burrs that result from sharpening the bevel.



PRUNING SAWS



Folding saw

A folding saw is easy to carry on a belt or in a pocket. It should be balanced and have a secure locking mechanism. This 14-in. Woodzig folding saw [about \$11.50] cuts from 1- to 3-in.-dia. branches. A unique feature of the saw is its flat teeth—resembling those of a chainsaw—that reduce binding, according to the manufacturer. The blade cuts on the pull only. It is designed to plane its way through wood and remove chips, rather than sawdust. Here the saw removes a dead limb stub from a red cedar tree. It's made by Omak Industries, Oregon Saw Chain Div., Box 22127, Portland, Ore. 97222, and sold at home and garden centers.

Pruning saws cut dry or green limbs from trees and shrubs. Blades are available in lengths up to 24 in. and most can cut limbs ranging from $\frac{1}{4}$ to 3 in. in diameter.



The Woodzig sharpening kit [about \$6] from Omak keeps the folding saw sharp. Clamp the file level in a vise, and use the 30° guide marks for proper angle. Sharpen teeth on one side, then reverse the saw.



Bow saw

Bow saws with their replaceable blades can cut three limbs with surprising speed. Make sure when you shop that the saw you select has a way to keep the blade taut—preferably with a sturdy tension lever.

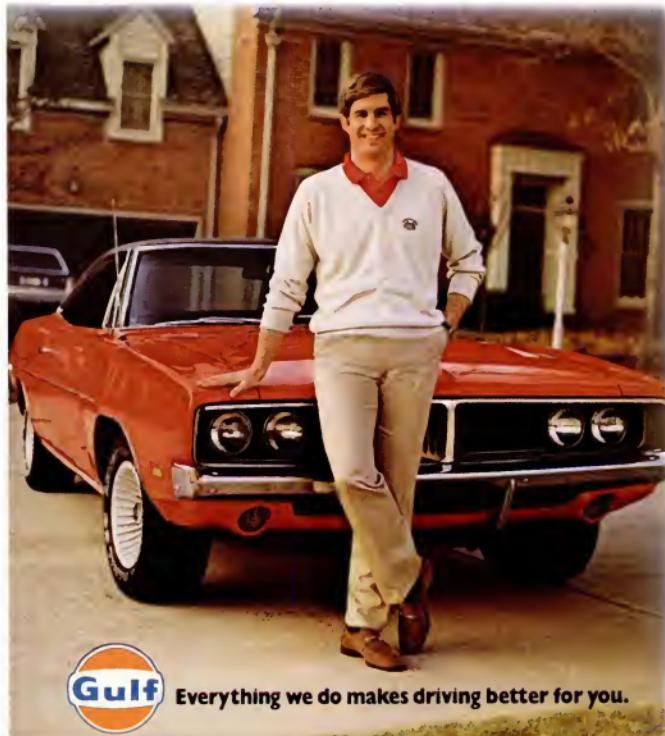
A unique feature of this 21-in. model [No. 666; \$14.70 postpaid] is a blade which can be rotated 360° and locked into any angle to get close cuts. For example, in the photo the blade is rotated almost 90° to the handle in order to avoid the limb immediately above the one being cut. The blade is stamped from a strip of hardened steel, sharpened and set. According to the manufacturer, an electro-induction hardening process makes the blade teeth much longer-lasting than standard bow saw blades. This eliminates the need for resetting and re-sharpening the teeth.

The bow saw is manufactured by Rak International, 190 Blydenburgh Rd., Central Islip, N.Y. 11722.

(Please turn to page 68)

Senior year, Dad lent me the money for this car.

I had to work construction all summer to pay him back. Do you think I'd use just any motor oil?



A '69 Charger, raised on
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switch. The driver's seat.

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PRUNING TOOLS



HEDGE SHEARS

Hand-held hedge shears often have serrated or wavy blades and/or a notch



The No. 512 hedge shears from True Friends (\$53.50 postpaid) have wavy-edge blades of surgical steel to give clean cuts. Ball bearings aid in producing an easy operation, and the handle fastener is adjustable to cut thicker items. In the photo, the shears are trimming a privet hedge. The tool is recommended to cut up to 1/4-in.-dia. branches, and it comes with built-in shock absorbers. From True Friends Garden Tools Inc., Box 1278, Cumming, Ga. 30130.



(Continued from page 66)

position to keep twigs in place for cutting. Wavy blades are curved to maintain a proper cutting angle from tip to handle. Shock absorbers are comfortable for the user, and discourage the shears from binding when closed.



Wavy blades can be sharpened with a round, fine silicon-carbide stone. Stroke over the wavy edge trying to maintain the factory angle. If the blade is filed flat and thin with no bevel, it will chip or roll [bend]. To sharpen, hold the blade in a vise and stroke from the blade point to the handle in one straight motion. Avoid sharpening the flat side or inside of the blades since they are hollow ground; file these only to remove burrs caused by sharpening.



5 POLE PRUNER

A pole or tree pruner is useful for trimming tall trees. Poles

usually extend 6 to 12 ft. The J-shaped hook holds a branch, which is then cut by a blade operated by a cable or pull rod. Saws attached to the cutting head can cut larger limbs than the hook and blade can handle.



Use a 6-in., single-cut mill bastard file in the field to sharpen the blade while it's in the pruner. Rest the blade against a solid surface, and with a gloved hand grip the head of the pruner. Hold it so the rod exposes the blade. To remove the blade for periodical sharpening in the shop, simply unscrew the head and file with an 8-in. file. Replacement blades are available through Green River.

Technical consultant: Bruce Rigg, The New York Botanical Gardens
Photos: George Anconia

SOURCES

Vise: No. 70-995, 3-in. (\$20) by Black & Decker, Towson, Md. 21204
Sharpeners: Ceramic sticks are available at cutlery stores. Sharpening stones are available by mail from Woodcraft Supply Corp., Box 4000, Woburn, Mass. 01888; catalog is \$3.

The IBM-compatible NTS/Heath HS-151 PC is included in three training programs.



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WORKSHOP MINICOURSE



Cutting dovetail joints by hand

The dovetail is a very strong, interlocking joint frequently used for drawer construction and other assemblies in high-quality furniture. Though it is often concealed, when fully exposed it exhibits an attractive pattern of alternating end grain segments that can lend an interesting design element to any piece.

There are numerous ways to cut this joint with power tools. But hand cutting will help develop your hand-tool skills and at the same time provide the real sense of satisfaction associated with traditional building methods.

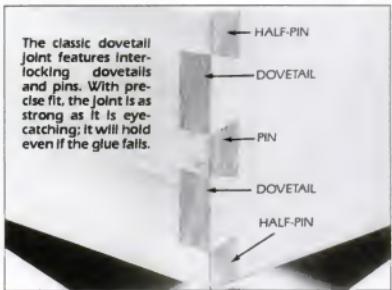
The angle of the dovetail relative to the stock edge should be about 80°. The photo at right shows how to set the T-bevel for this angle without the need of a protractor. The size and spacing of the tails and pins, however, are a matter of personal preference. Just make sure that the half-pins on the top and bottom of the joint are at least as wide as they are deep. Otherwise, you run the risk of them breaking off.

Begin by laying out and cutting the dovetail member first, then use this board as a pattern to layout the pins in the mating board.

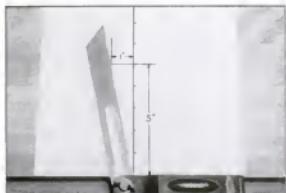
Work with sharp, fine tooth saw blades to cut out the bulk of the waste. Then, finish each cut with super-sharp chisels to get the best results.

—Rosario Capostoto

The classic dovetail joint features interlocking dovetails and pins. With precise fit, the joint is as strong as it is eye-catching; it will hold even if the glue fails.



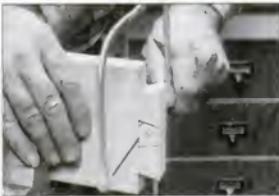
To cut joint by hand, begin with precise layout. Use combination square to mark edges and T-bevel to mark surfaces.



Establish dovetail angle (about 80°) without protractor by drawing 1-to-5 proportion on paper and setting T-bevel blade to line.



Clearly mark waste then make dovetail depth cuts first. Use fine-tooth dovetail saw and be sure to cut on waste side of line.



Make crosscuts between dovetails using coping saw. Make sure that blade follows line on both sides of board.



Trim edges of dovetails to layout line using sharp chisel. Then, use knife to clean out corners that chisel blade can't reach.



When tall cuts are complete, use board as template to establish position of mating pins. Mark pins with knife for precision.



Cut pins like tails were cut using dovetail and coping saws. Then, trim sides of pins square with chisel before cleaning crosscut.



Test-fit joint frequently to check progress. Mark any high spots with soft pencil, then carefully shave to fit using sharp chisel.

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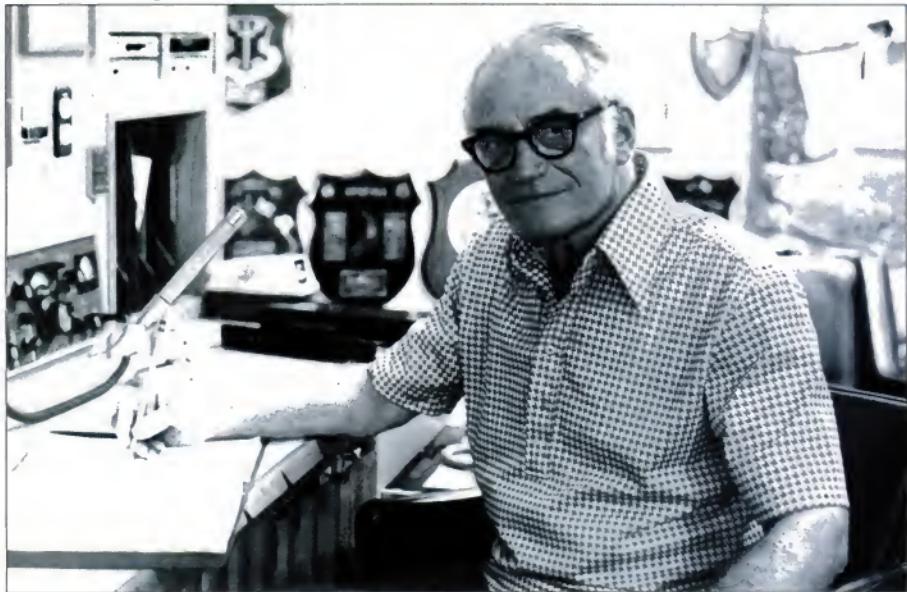
In a comparison test using industry standards — SAE J806b — the FL-1A lasted on average almost twice as long. And with this longer life span, it trapped on average twice as much dirt as its leading competitors.

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Barry Goldwater: K7UGA



PM PHOTOS: GARY O'BRIEN

'At some point I'll say my name is Barry and I work in Washington.'

BY MARC STERN

Sen. Barry Goldwater makes an entry in the log book of one of his three radio units (above). His call letters are so well known that he gets a lot of traffic.

service.' Barry Goldwater's history as an amateur radio operator goes back 63 of his 76 years. Most of the time he has provided services to people who are in desperate need.

During the Vietnam war, for instance, Goldwater set up a Military Affiliate Radio Service (MARS) at his Arizona home. Working with 34 volunteers he managed to "patch through" more than 300,000 phone calls from American families to their loved ones in the combat zone.

Goldwater may thus seem like a simple radio devotee. He has built rigs himself and has one in his office, and others in his Washington apartment and Arizona home. But his pastimes reach much further. The model cars

sitting in his office were built with his own hands. He still likes to assemble electronics kits and proudly relates how he has assembled TV, clocks and stereos from scratch. For over a year he has been cataloging the 15,000-plus negatives that testify to his strong abilities as a photographer.

But radio is the thread that ties together all of Goldwater's other works. He maintains regular contact with a Soviet amateur radio operator. And, often, he talks to amateurs at home. His call letters—K7UGA—are well known to other hams.

"I generally don't talk politics, but I can't sit here and tell you it doesn't creep into the conversation," Goldwater says. "Generally, we'll talk along and at some point I'll say my name is Barry and I work in Washington."

"Then, they'll ask me what I do in Washington, and I usually say I work for the government."

In his fifth Senate term, Goldwater is looked upon as the inspired voice of conservatism and he works many nights past midnight. But he does stop now and then to talk with the world.

"Having a good ragchew," he smiles, "is important to me."

The office is like the main trunk of a megalopolis telephone line. Messengers rush in and out carrying documents from all over Washington. Phones are ringing off the hook. The Senate session is drawing to a close and one of the legends of Washington is moving with the flow to help shepherd last-minute bills. Surrounded by model cars, model aircraft and many awards, Sen. Barry Goldwater (R-Ariz.) betrays none of the raw emotion buzzing all about him. In fact, he is about to take a few minutes to swivel around in his seat to the amateur radio rig that is sitting behind his desk.

"I can understand why some people call this (ham radio operations) a hobby," Goldwater says, "but I call it a



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ARMY. BE ALL YOU CAN BE.

Build This Graceful **Wheelbarrow**

Here's a wood workhorse designed to tote almost anything around your yard.

BY TOM CRABB

This simple-to-build and inexpensive wheelbarrow has one great advantage over the standard tub design: Its sides are removable. This allows you to safely carry such things as firewood logs that often span the sides of conventional wheelbarrows. And, it makes transporting heavy objects easier because they don't have to be lifted as high to reach the bed.

Begin by cutting the handles and lower supports to length. Then cut 8 wedges, 14 in. long, to form the 16° angle where both pieces meet at the front. Save the wedge-shaped scrap for later. Cut the pieces to the shapes shown in the drawing pattern grid. Then, clamp these pieces together and bore the lag screw pilot holes through both at the same time. Install the bolts, then bore holes for the wheel axle or bearings using a drill press or a drill guide to set the exact 95° angle.

Lay out the legs and upright arms, and cut and fit their half-lap joints.



Removable sides allow easy loading.
To unload soil or cut grass, remove one side and tilt the wheelbarrow.



Next, glue and screw the wedges, left from before, to top edges of the handles. Countersink the screwheads. Mount the wheel, taking care to position the side assemblies equidistant from the center of the wheel.

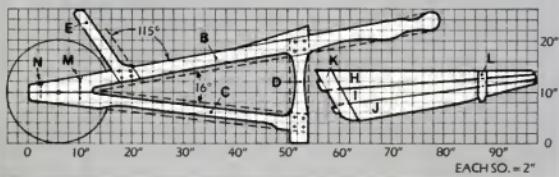
Secure the front and the rear 1×4 bed slats. They should be centered and screwed into the handle and upright.

arm with four countersunk screws each. The remaining slats need only two screws each. Work from the ends toward the curve. At the curve, rip and bevel 1×4 stock to fit the space.

To build the sides, begin with the front side post pieces. Hold each piece against the outside edge of the bed slats so it overlaps at least 1 in. to allow for tenons. Draw the contour of the slats on the 1×4 , then mark the positions of the tenons as shown. Cut the board. Cut the rear side posts in a similar way, then transfer the tenon positions to the bed slats to establish the mortises. Cut mortises with a jig saw, slightly oversized, so the side will slide in freely.

Mark and cut the sides to fit the bed contour, leaving $\frac{1}{4}$ in. between slats, and screw and glue them to the posts. After filling or plugging all screw holes, sand the entire wheelbarrow and apply several coats of spar varnish. FM

WHEELBARROW



MATERIALS LIST — WHEELBARROW

Key No.	Size and description (use)
A	20"-dia. steel wheel
B	2 1 1/2 x 3 1/8" x 30" yellow pine (handle)
C	2 1 1/2 x 3 1/8" x 54" yellow pine (lower support)
D	2 1 1/2 x 3 1/8" x 21" yellow pine (legs)
E	2 1 1/2 x 3 1/8" x 18" yellow pine (upright arm)
F	12 3/4 x 3 1/8" x 18" yellow pine (bed stat)
G	12 3/4 x 3 1/8" x 24" yellow pine (bed stat)
H	2 3/4 x 4 1/2" x 30" yellow pine (side)
I	2 3/4 x 4 1/2" x 41" yellow pine (side)
J	2 3/4 x 4 1/2" x 39" yellow pine (side)
K	2 3/4 x 3 1/2" x 13" yellow pine (front side post)
L	2 3/4 x 3 1/2" x 8" yellow pine (rear side post)
M	3 1/2" x 6" lag screw
N	2 1/2" x 3 1/2" screw
O	48" 1" No. 8 fl screw
P	34" 1 1/4" No. 8 fl screw
Q	4" 2" No. 8 fl screw

For people who love to play in the mud.

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IT

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IGNITION SYSTEMS

A CENTURY OF PROGRESS

100
YEARS

The internal combustion trigger has progressed from hot metal tubes to computer-controlled electronics.

BY MORT SCHULTZ
Illustrations by Pat Ruggero

Hot-tube ignition on Daimler engines of the 1880s used an external burner to heat a closed metal tube red hot. The tube was kept incandescent and ignited the fuel mixture in much the same way as a glow plug in a two-stroke model airplane engine. Raw gas was burned in the tray under the burner for starting.

COMBUSTION CHAMBER

INTAKE VALVE

FUEL TANK

HOT TUBE

BURNER

PISTON

DAIMLER HOT-TUBE IGNITION

COMPUTER-CONTROLLED COIL MODULE

GM ALL-ELECTRONIC IGNITION

SPARKPLUG CABLES

Early one September morning in 1908, Ernest Sweet, chief engineer for the Cadillac Motor Car Co., stepped off a train in Dayton, Ohio. He was met by an engineer who worked for National Cash Register.

In the five years he had spent at NCR, the younger man—he was 32—had invented an electrically operated cash register that did away with hand cranking. He had also developed OK Charge Phone, the nation's first "automated" credit checking system. This magnetic device, placed in a cash register, allowed a sales person to press register keys and transmit information about a charge customer's purchase to a central office. Approval or disapproval was then telephoned back to the counter. The young man's contemporaries thought him a genius.

However, Sweet was not in Dayton to discuss cash registers. At the urging of his boss, Henry M. Leland, he was there

(Please turn to page 82)

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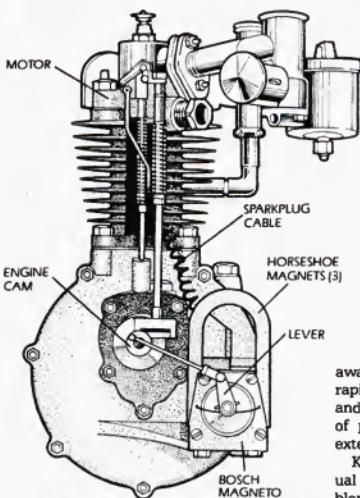
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No other fuel combines
cleanliness, efficiency, and
economy like natural gas.



Early Bosch magneto used three horseshoe magnets and an armature moved by a cam and lever to generate spark current.

to test-drive a Cadillac Roadster owned by the NCR engineer. Leland had received a letter from the Dayton resident describing a "flawless" battery ignition system for motor vehicles. Magneto ignition was the standard in those days because battery ignition just didn't work. Sparkplugs fouled, vibrators failed and batteries often gave out after 500 miles. Brief encounters with battery ignition by other carmakers—Duryea in 1893, for example—caused them to return to the reliable magneto.

For the next eight hours, Sweet drove the Cadillac over the hills surrounding Dayton, putting the Roadster through every rigorous test he knew. As the young engineer had promised, the igni-

tion system performed flawlessly. As a result of this test, Leland met the NCR engineer several weeks later at Cadillac headquarters in Detroit to personally hand him a contract calling for 8,000 of his battery ignition units—enough for every Cadillac that would be produced in 1910. The young engineer was Charles Franklin Kettering. In the years ahead, his influence on General Motors would rival that of Leland.

What had Kettering done that allowed a battery ignition to perform reliably? To start with, he combined the standard four induction coils (one for each sparkplug) into one by placing them in a heat-resistant, solidly anchored, armored-steel box and connecting them in series. This did

away with the nagging problem of rapid coil failure caused by vibration and heat, and also allowed conservation of power. Battery life was therefore extended.

Kettering also eliminated the individual vibrators (also called "tremblers")—one for each coil—that made and broke the circuit. He replaced them with a single master set of contact points connected to a condenser. The condenser drew excess current away from the points, contributing to their longevity.

Tremblers (steel springs) were susceptible to loosening by vibration. This required motorists to make frequent adjustments. The devices also quickly burned themselves to death as a result of electrical arcing. Kettering's ignition produced a much hotter spark than ever before, using less battery current, which extended component life.

The contract Leland handed Kettering enabled him to quit NCR and begin

his own business, which he called Dayton Engineering Laboratories Co.—Delco for short. More important, the contract put Kettering's mind solely on perfecting what was to be the standard auto ignition system—one that's still with us today—and on development of the self-starter.

Yet, when the 1910 Cadillac Model 30 hit the showrooms, customers found that it possessed two independent ignition systems—the much-heralded Delco and the standard magneto, installed just in case.

Although it was only another two years before dry cells were replaced by storage batteries, it was quite a while longer before storage batteries attained any degree of reliability.

As late as 1935, some manufacturers were still placing magnetos into cars. But, for all intents and purposes, the end of the magneto came with the end of the Model T Ford in 1927. Ford refused to trust battery ignition for the Model T, even after the development of more reliable storage batteries. So, every Model T came with a self-starter and battery for "modern starting," and a hand crank that sprung the magneto to life if the self-starter or battery failed.

Four basic systems

There have been only four basic auto ignition systems during the last 100 years—hot tube, magneto, battery and computerized—plus a number of oddball variations. As late as 1924, systems using lighter flints and moving files (sometimes attached to the piston) were being tried. Engines in which sliding valves exposed the fuel mixture to a pilot light had proved dangerous, and the hot tube finicky.

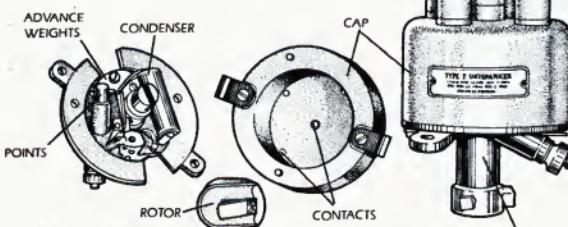
The hot tube was just that—a closed metal tube that projected from the cylinder and was heated red hot by a sort of Bunsen burner. Because it was always hot, ignition took place as the compression rose—there was no "timing" as such.

The advantage of a spark ignition is that, not only can you time it, but the flame doesn't blow out when you drive fast. The earliest sparks were produced by a tiny generator that employed permanent magnets and was therefore called a magneto.

Although several inventors are credited with developing magneto ignition, Siegfried Marcus was issued a patent in 1883 for a "magneto-electric ignition system." It proved to be the basis for an automotive ignition system that lasted until battery ignition took over.

Marcus's system used two contact points installed inside the cylinder: one was stationary, the other, movable. The stationary point was connected to the magneto, or generator. The movable

(Please turn to page 84)



Atwater Kent Unisparke of 1912 had all the parts of a modern breaker-point system. Points were opened by a spring-loaded "snapper" arm. ASSEMBLED

MONROE® GAS-MATIC® THE SHOCK THAT SHOULD'VE BEEN ON YOUR CAR IN THE FIRST PLACE.

Now there's a replacement shock that's so superior, so advanced, you'll wonder why it didn't come on your car in the first place. Monroe Gas-Matic. The most advanced shock we've ever made.

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Gas-Matic features a nitrogen gas charge (1), and a Teflon/steel priming valve (2), that drastically reduce aeration for less shock fade. This advanced technology allowed us to open up the valves (3) for reduced ride harshness.



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In comparison testing to conventional shocks, Gas-Matic handles better. Rides better. And gives you greater control without sacrificing comfort.

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We built Gas-Matic to be the best. On every type of road surface. In a recent consumer ride test that

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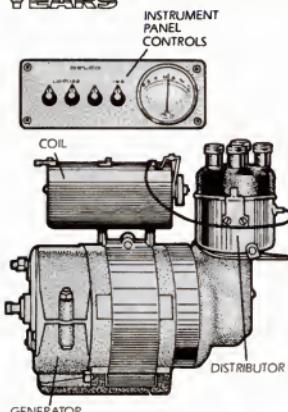
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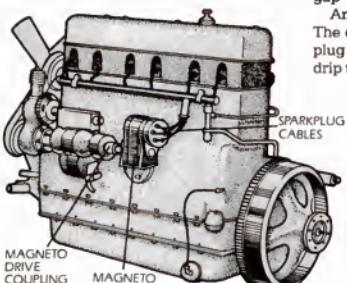


GAS-MATIC®

THE MOST ADVANCED SHOCKS AND STRUTS
MONROE HAS EVER MADE.



Delco magneto of the 1920s has its coil, generator and distributor in a single unit.



Bosch high-tension magneto on the 1918 Marmon straight Six, like many others, was driven off the external water pump.

point was mounted on a small plate. As the plate moved, it brought the two points into contact. At this moment, an external pushrod operated by the cam-shaft interfered to break the circuit and produce a spark.

The Marcus low-voltage make-and-break ignition system served well as long as motor cars were driven at low speeds by single-cylinder engines. But, as multicylinder engines became popular and roads improved, the need for an ignition system that could deliver a steady stream of sparks became apparent. The result was a jump-spark system that used induction coils, tremblers and sparkplugs.

Some of those plugs were ingeniously designed to compensate for fouling, which was frequent. They carried over to battery ignition systems.

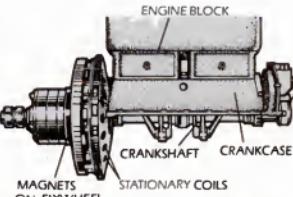
One popular type had an insulated knob at the top that was connected to a small metal rod. It allowed the motorist to adjust a secondary gap, which could be viewed through a window in the plug's top section. Fiddling with this gap was said to blast away deposits.

Another type was a priming plug. The driver opened a small valve on the plug that allowed gas in a reservoir to drip through the plug itself and into the cylinder. There was, however, a problem: If the motorist didn't close the priming valves tightly before starting, the engine either flooded or, if ignition did take place, was transformed into a flame thrower.

Then there was a plug with electrodes at both ends. If the motorist experienced plug failure, he simply unscrewed a terminal cap, turned the plug end for end, reattached the terminal cap to the fouled end, and he had a fresh plug ready to go.

There have been many other ignition developments over the years—spark advance components, for example. The first manual spark advance system was brought out by Packard in 1901. For years after, drivers controlled spark advance by a lever on the steering wheel hub. Studebaker pioneered the vacuum advance in 1930, and Chrysler installed the first combination vacuum and centrifugal advance unit in 1931. During the 1980s, on-board computers took over the job of spark advance. A computer can generate three-dimensional timing "maps," as opposed to the old, two-dimensional curves.

In 1961, the Delco Division of General Motors announced an ignition system that eliminated contact points and condensers by using electronic circuitry. At



Model T magneto built into the flywheel worked as soon as the crankshaft turned.

the time, Herman Hartzell, Delco's chief engineer, said the new breakerless system was being studied with an eye toward installing it on trucks, tractors and heavy-duty stationary engines. Chrysler made a similar system standard equipment in 1972, and "point-less" ignition became universal.

Two years ago, a new computerized system reared its head—probably the most revolutionary development in ignition since 1908. Introduced by Buick on its 3-liter V6 engines, it eliminates the mechanical distributor entirely. Sensors on the engine detect crankshaft angle and, therefore, piston position. This information is fed to the engine-control computer which, at the right moment, triggers one of three coils in a black box. Each coil fires two sparkplugs simultaneously, one near the end of piston's compression stroke, igniting the air-fuel mixture, and the other near the end of the opposing piston's exhaust stroke, where it fires harmlessly. Each pair of plugs fires once for every crankshaft revolution.

Variations of GM's ignition are likely to show up on all gasoline engines of the future, replacing distributors just as the Delco breaker point system took over from the magneto.



Antifoul plugs (left to right): Fan Flame model with rotating electrode; terminal/cap and double plug could be reversed when fouled; priming plug lets you pour gas into cylinders for starting; adjustable gap blasted deposits; removable core allowed quick cleaning.

PM thanks the research library of the Motor Vehicle Manufacturers Assn. (MVMA) for its help in preparing this series of articles.

Caprice Classic

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TODAY'S CHEVROLET

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HOT NEW GEAR FOR FIREFIGHTERS

It takes more than courage to fight a fire in the 1980s. It takes a full array of high-tech equipment.

BY DENNIS ESKOW
Science Editor

Photos by Brian Wolff

The lead truck for New York City's Hazardous Materials team (right) carries a specialized crew and a wide range of suits, equipment and books (above).

An acrid cloud of smoke wafts down the hospital corridor as squads of nurses and orderlies wheel patients to an emergency elevator. There is little panic, but the tension is even thicker than the building smoke. A shorted electrical wire has started a fire in the hospital's X-ray clinic.

Already firemen are climbing the stairs, connecting hoses to standpipes or bringing along hand-held chemical fire extinguishers. Everything about the fire is well within the firefighters' control, but as they enter the fire scene, a

doctor calls out: "That's radioactive! Hazmat's on the way up."

Hazmat is the buzz word of firefighting in the 1980s. It stands for Hazardous Materials. In New York, where the hospital fire was put out within 20 minutes—and in Los Angeles, London and Tokyo—Hazmat squads have become the SWAT team of fire.

"The hospital fire was an all-hands alarm—three engine companies and two ladder companies responded—and they had the situation fully under control," New York Fire Lt. John Calderone

recalls. "But it takes special training to handle radioactive material. So they called us in, too."

The New York Hazmat team was created out of the chaos that plagues all traditional fire departments. It happened on a muggy August day in 1980. "A propane truck was crossing the George Washington Bridge from New Jersey at about 10 a.m.," says Calderone. "Rush hour was over, so when the truck sprung a leak, there wasn't much of a panic." But within an hour, the busiest bridge in the United States had





to be shut down. Port Authority police and fire officials, who patrol the bridge, contacted a plumbing supply house and a truck was dispatched. The hole was stopped up with a makeshift tank plug. But now authorities had to contend with liquid propane that had spilled all over the road.

"No one knew exactly how to clean it up, or exactly who to call," Calderone notes. "The New York Fire Department was called in and so were a couple of other agencies. It took all the experts until after 6 that night to clean up the propane. The cleanup went smoothly, but there was a traffic jam on the New Jersey Turnpike all the way to Philadelphia. We're trying to get it into the *Guinness Book of Records* as the world's longest traffic jam."

By September 1980, the New York Hazmat team was formed on paper. And four years later, after extensive research and training, the first Hazmat team went on duty. It took four years to put all the pieces together because of the complexity of working with hazardous material. The equipment is specialized and the knowledge required to do the job right is extensive. Even today, when the Hazmat team responds to a call, it moves slowly—just the opposite of traditional fire companies. There are too many chances for mistakes.

The classic mistake was made in England in 1982. A suburban fire department was called to a blaze at a laboratory outside London. The firefighters had the flames out in 45 minutes and damage to the building was slight. Two firemen were overcome by smoke and were rushed to a hospital.

When the stricken firemen arrived at



Los Angeles Hazmat team (top of page) turns out in full gear. A Long Island firefighter looks through smoke with a thermal imaging camera (top center). At a chemical fire scene, a firefighter is washed down. Water carries contaminants to a tiny inflatable pool. The 140-foot tower ladder (right) is for skyscraper fires.





the hospital, emergency room physicians questioned them about the nature of the fire. They had worked in a classified area loaded with highly radioactive chemicals. When doctors took Geiger counter readings of the two firemen, they promptly shut down the emergency room and cordoned off the roadways leading from the fire scene to the hospital. Over the next 24 hours, a British Army team scrubbed down the emergency room and hospital corridors and dropped a gritty tar-like substance along the roadways to mop up any residual radioactive material. The suits worn by the firemen were burned and the two men remained hospitalized under observation for two days before being released.

Scenarios like that have prompted New York and Los Angeles to arm their Hazmat team with a rolling library of chemistry books, an amazing array of firefighting suits and a range of tools and equipment that staggers the imagination. The New York unit carries a computer on its lead truck, and the Los Angeles squad has one on order.

"The toughest assignment we face is identifying chemicals when we get to a scene," says Capt. Mike Conti of the Los Angeles Fire Department's Hazmat unit. "We carry a number of analyzers that help us figure out what chemical is involved. So many times, it's a mystery

(Please turn to page 134)

Firefighters (top of page) try new positive pressure suits at Los Angeles Fire Academy. The L.A. scuba diving team (center) uses a Styrofoam floating dock connected to a fireboat to battle a wharf blaze. And an L.A. Hazmat team member shuts a leaking valve on a tanker car using a new Hurst spreader tool.



THUNDER

Formula for water-borne rolling thunder: Take one megapower V8 outboard engine, drop it into an aerodynamic, hydrodynamic tunnel hull, add one driver with excessive guts, and mix well. That's Formula One boat racing, 1985.

BY CLIFF GROMER

At 112 mph, Barry Woods chops power slightly and cranks the small black steering wheel hard left. Then, mashing down the accelerator, he slingshots a tight U-turn around a buoy in an explosion of water.

I am seated behind Woods, almost on top of him, in the cramped cockpit of a special two-seat version of a Formula One outboard race boat. I try to sit upright but the g-forces in the turn (some 3g's at 90 mph) want to flop my helmeted head onto my shoulder, or maybe pluck it from my body and pitch it into the water. All this just to write a magazine article?

Behind me is a monster V8 outboard ready to unleash more than 400 hp anytime Woods wants it. Asking for power at the wrong time can plunge the craft into an extravaganza of destruc-



Helping pump out over 400 hp from just 214 cu. in. are eight two-barrel carburetors. Fiberglass cowlings are aerodynamic in design and make for colorful watching. At right, pre-race activity can be just as interesting as the race.



BOATS

Over 400 hp can push these boats to speeds up to 150 mph.



Front-mounted cockpit in the tunnel boats is not for the claustrophobic. Steering and accelerator have automotive-type controls. At \$40,000 apiece for a ready-to-run boat, most Formula One teams need corporate sponsors.

tion instead of pushing it to the checkered flag.

Woods is one of more than 30 top U.S. and European drivers competing in Formula One for a total purse of more than \$300,000 distributed over a six-race series. Each event consists of a number of 20 to 50 lap heats with up to 25 boats on a tight 1.4-mile course. The only major limitation in Formula One—the fastest category of outboard boat racing—is that the motors must have a displacement of more than 2 liters.

Several Formula One engines are available in V6 configuration, but really serious drivers bank on an awesome 3.5-liter (214-cu.-in.) V8 manufactured by Outboard Marine Corp. under the Johnson and Evinrude brands. The heart of this mega-mill is an aluminum block, loop charged, two-stroke with two banks of four cylinders set at 90°. Each cylinder gulps gas (94 octane) through its own two-barrel carburetor. Each carb has its own reed block, each with 12 reeds. At full song, these engines shriek along at 10,000 rpm, and last only seven hours under racing conditions before they have to be replaced—at \$22,000 a copy! By comparison, Evinrude's newly released top horsepower consumer V8 outboard, the 3.6XP, cranks out an estimated 300+ with a long-life 5,500-rpm redline.

The loop-charge design on both racing and consumer V8s makes the incoming fuel drive out exhaust gases

(Please turn to page 126)

'85
IMPORTS

The Sports Sedans



As part of PM's annual look at all the cars from abroad, we singled out the fun-to-drive, family-size cars for a head-to-head test.

Sports sedans were invented in Europe. They're well-made, five-passenger cars that are modest in size, appearance and appetite for fuel, yet can outperform all but the fastest two-seater sports cars. The market for these \$15,000 to \$25,000 cars has burgeoned from 50,000 cars per year a decade ago to 500,000 today.



BMW's 22 mpg was best fuel economy measured on a variety of roads from divided highways to country lanes. We subjectively evaluated each car in 22 areas during back-to-back drives.

We took eight of these desirable cars to Raceway Park in Englewood, N.J., and ran them through our standard sequence of performance tests. Four drivers also took each car over identical test loops that included divided highway, rolling country two-lane, stop-and-go traffic and neighborhood suburban streets. After the loops, each driver rated each car in 22 different categories. Our final ranking of the cars represents a consensus of all four testers.

Usually when we do this type of comparison test, there are one or two cars that are spectacularly better than the rest, a few that are okay, and a couple destined to be the Edsels of our era. Not so this time. Both at the track and in our subjective evaluations, this group of cars was so close—and the average so high—that it was difficult to choose among them. But we did come up with a ranking.

XR4Ti Merkur

The unanimous winner of our test is a car you've probably never heard of unless you're an avid auto buff. The Merkur is actually a German Ford Sierra XR4Ti, modified for the American market. The Sierra



Ready for a road test, front row, left to right, are Nissan Maxima, Mercedes-Benz 190E 2.3, Saab Turbo, Merkur XR4Ti. Rear: Audi 5000S Turbo, Volvo 740 Turbo, Peugeot 505 Turbo, BMW 325e.

is Ford of Europe's intermediate, sized between the Escort and the Granada. In Germany, it competes with small BMW and Mercedes models.

The XR4Ti is the top-line sporty model, as you might suspect from its biplane rear spoiler and add-ons. In Germany it comes with a 150-hp, 2.8-liter V6 and will top 130 mph. For the American market, Ford takes the basic Sierra off the Ghent, Belgium, assembly line and then the Karmann works in Germany makes over 700 minor changes and installs the same 175-hp Brazilian-built 2.3-liter, turbocharged Four that's in the Turbo Thunderbird.

Our testers were totally smitten by the Merkur's looks, calling it a real head-turner, and bold and daring. Beneath the sleek exterior hides a hatchback interior that's unbelievably spacious. It could swallow our photographer's 10-foot ladder, or five adults. The trunk is cavernous, and well shaped. The Merkur is a premier example of superb styling and clever space utilization on a conventional front-engine, rear-drive chassis. List price for this classy package is a comparative bargain at \$16,500.

German designers are famous for attention to

ergonomics, and the Merkur has to be a world leader in that regard, all with typical German quality.

The infinitely adjustable bucket seats came in for special praise—a truly snug harbor, lots of lumbar and side support, sumptuous leather, like a well-made German executive office chair. The Merkur did not win all our track tests, but was fastest in the quarter-



Merkur XR4Ti did best in the braking and acceleration tests and was the overwhelming favorite on the road. Spectacular styling and performance made this hot rod the clear winner.

mile, best in braking and more than competitive in the slalom and skidpad tests. All together, it's the best performance machine in the group—easy to drive fast.

According to Ford's engineers, the turbocharged, fuel-injected, computer-controlled Turbo 2.3 actually outperforms the European V6 right up to 130 mph. New this year is a water-cooled bearing for the turbocharger, which should make this engine even more reliable. It's not an engine you'd want to service yourself, but it is less exotic than the engine in something like a Mercedes or BMW.

Our testers simply had no complaints about the Merkur XR4Ti.

Nissan Maxima

There were only two all-new cars in our import test group, the Merkur and the Maxima SE, which finished second. This should tell you something about the pace of development in the sport sedan ranks. Sit on your laurels for more than a year, and you're apt to be sitting out the game.

The Merkur and Maxima couldn't be more different in design and execution. The only characteristics that the two cars share are superior performance, quality and value. At \$13,694, the Maxima SE is \$5,000 to \$11,000 less than the car it beat, and \$5,000 less than the Merkur.

When it came time to engineer a new Maxima, most people would simply have based it on the 300ZX sports car, just as the previous Maxima was a four-door 240Z. But that's too easy for Nissan. They engineered a whole new front-wheel-drive chassis to accept the 3.0-liter V6 from the 300ZX. The new

rule in Japan seems to be that sports cars are rear-drive and sedans must be front-wheel-drive.

To be honest, we couldn't tell the difference. The Maxima goes, stops and handles with rare aplomb. It was right near the top in every performance test, easy to drive and perfectly comfortable at speed.

The big V6 has that lazy, high-gear feel that used to be the exclusive province of American V8s.

Unlike the traditional luxury sedan,



All-new Nissan Maxima ranked second on the road and near the top of our track tests.

the soft and cushy Maxima has plenty of power to pick up its skirts and fly when you mash the throttle. All you have to do is set the electronically adjustable suspension on FIRM, and the Maxima will outslalom and outbrake an Audi, Mercedes or Saab.

The Maxima is not perfect. There's too much nose dive under braking, the shifter is imprecise, the suspension—even when you set it on FIRM—is too soft and the handling on Yokohoma tires feels sloppy. But the engine is super, the ergonomics are excellent and the quality is impeccable. This car has the right stuff, it just needs to be sorted out a bit better.

Prepared by the PM Auto Dept.

Text by Rich Taylor

Photos by Peter Terzer

BMW 325e

The 318i and its more expensive sibling, the 325e, are little sedans with steep price tags, giving excellent performance and unrivaled snob appeal.

Happily, the new 325e is also a pretty good car. Actually it's a 318i, but with a 2.7-liter six-cylinder engine in place of the 1.8-liter Four.

BMW has two engine families. The "I" engines are high-revving performance powerplants; the "e" engines are low-revving fuel economy specials. Redline on the 325e is 4,700 rpm. At 60 mph in FIFTH, it's barely ticking over at 1,900 rpm.

This has some undeniable benefits. Even with the next largest engine after the Maxima's 3.0-liter V6, the 325e returned the best gas mileage of this group, nearly 12 percent better than the Maxima and the Mercedes, which tied for second. The little BMW is also remarkably quiet and smooth because its slick Six is so understressed.

Put your foot down, however, and it's hard to deny the effectiveness of 2.7 liters in a 2,700-pound car. The 325e was second on the dragstrip behind the Merkur XR4Ti.

The 325e felt better when driven hard than any other car in this group. It won the skidpad testing, was second behind the surprising Volvo on the slalom and stopped with reassuring suddenness. On the other hand, the rounded three-box styling is overly conservative, and the interior is a tight fit. BMW just introduced a four-door version of the 325e (too late for our test), which should compete head-to-head with the Mercedes 190E 2.3.

Volvo 740 Turbo

The 740 Turbo is the low-priced version of the \$24,000 760 Turbo. In order to bring the price down, Volvo specified black-painted trim in place of

(Please turn to page 144)

IMPORTED SPORTS SEDANS—PM's ROAD TEST RESULTS

CAR	GAS MILEAGE (EPA city/PM test)	1/4-MILE (sec. @ mph)	SLALOM ¹ (mph)	SKIDPAD ² (cw/ccw)	BRAKING (ft.) (60-0 mph)	TRUNK CAP ³ INDEX	INTERIOR ⁴ SPACE INDEX	ROAD TEST ⁵ RANKING
Audi 5000S Turbo	19.0/17.4	17.86 @ 78.53	58.02	.74/.74	155	16	129.2	7
BMW 325e	23.0/22.6	16.41 @ 83.10	59.76	.78/.78	132	18	112.6	3
Mercedes-Benz 190E2.3	19.0/20.3	17.33 @ 79.85	56.91	.73/.75	145	13	114.3	8
Merkur XR4Ti	20.0/17.1	16.04 @ 85.38	58.73	.76/.75	127	16*	112.4	1
Nissan Maxima	19.0/20.0	17.01 @ 82.34	58.88	.74/.78	129	16	111.1	2
Peugeot 505 Turbo	18.0/18.2	16.72 @ 81.96	57.39	.74/.78	147	12	116.0	8
Saab Turbo	19.0/18.1	16.80 @ 82.85	56.57	.76/.78	152	16*	112.0	5
Volvo 740 Turbo	19.0/17.4	16.83 @ 81.26	61.06	.73/.78	160	15	126.6	4

1. Best speed achieved while weaving through seven cones placed 100 feet apart; the higher the speed, the better the transient handling.

2. G-forces generated during steady-state cornering around a 200-foot diameter circle; cw = clockwise, ccw = counterclockwise.

3. The number of standard-size grocery bags that will stand upright (1-inch crush space permitted) in the trunk.

4. Front-seat width x headroom x legroom + rear-seat width x headroom x legroom ÷ 1,000.

5. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.

*Hatchback with folding rear seats/back.

Bold numbers indicate best performance.

The New Imports Stress More Luxury And Performance

If the import restrictions are lifted on Japanese cars next month, which seems likely, the Japanese manufacturers will probably increase sales by 10 percent each year until the end of the decade. This will give them 30 percent of the total U.S. market by 1990—about what they had before the quotas began. At the same time, European importers are reporting record sales, particularly of luxury and sports models. Companies like Jaguar and Saab have more than tripled their sales in just a few years, and confidently expect this rate of growth to continue as long as the U.S. economy booms. Europeans could be zeroing in on 10 percent of the total U.S. market by the end of the decade.

Happily, both European and Japanese cars are better than ever. The emphasis is on high-tech engineering for sporty fun, which leads to everything from economy cars with turbocharged engines to luxury cars that can outcorner a Ferrari.



CHEVROLET SPECTRUM is Isuzu-built and is for sale only on the East Coast.

JAPANESE CARS Chevrolet nameplates

Potentially the biggest importer of all—announced goal is 1 million Japanese cars each year—all-American Chevrolet would love to get the restrictions lifted so they can sell more of their



AUDI 4000 sedan, Quattro and Coupe GT have been reskinned to improve aerodynamics, and the upgraded interior makes the inside match the rest of the car's quality level.

two new models. The smallest Chevy—indeed, the smallest new car you can buy—is the Sprint. This is a 1-liter, 1,500-pound econobox priced at \$5,151 and built by Suzuki. Only 17,000 will be imported in 1985, and only in nine western states.

On the East Coast, Chevy dealers will sell the slightly larger Spectrum, a 1.5-liter front driver built by Isuzu in Japan. Chevrolet would like to import at least 200,000 a year; the restrictions cut that to 29,500 for 1985.

Then there's the new Chevrolet Nova, a modified Toyota Corolla. It will be built in a joint-venture factory in Fremont, Calif., in which Toyota holds a controlling interest. Expect 200,000 Novas a year. Neither the Sprint, Spectrum or Nova is particularly innovative, but in the showroom, the Chevrolet name on the hood is worth more than all the engineering expertise in the world.

Honda

The trend-setting Honda Civic wagon will be available with four-wheel drive starting this spring. The sleek but miserly CRX HF has a larger 1,500-cc engine, and a new fuel-injected CRX Si will come with alloy wheels, sunroof and lots more horsepower. It ought to set the sports car world on its ear. Civic three-door and four-door models are unchanged. The award-winning Accord and Prelude are the same as last year, but top-line models get fuel injection to make them even faster.

Isuzu

Isuzu's I-Mark—a Japanese Chevrolet—is being replaced with the same Spectrum supplied to Chevrolet. At Isuzu dealers, it will be called I-Mark, and will come as a three-door hatchback or four-door sedan. The only engine is a

1.5-liter Four—no more Isuzu diesels. The Spectrum/I-Mark is not a great car, but it will give Isuzu an up-to-date economy car that should be more than competitive with the Tercel, GLC and similar cars.

The Impulse has a new intercooled turbocharger system for the 2-liter, overhead-cam Four to finally give the



FERRARI MONDIAL will do nicely for those who can't afford the Testarossa.

lovely Giugiaro-styled coupe the power it deserves. All told, it will be the most stylish performance car on the market.

Mazda

Mazda leads its class in every market segment, and the dealers can't get enough cars now. So why change? The GLC, 626 and RX-7 have only some minor cosmetic changes, though the B2000 pickup truck is all-new. A completely new RX-7 is planned for 1986; the GLC will get redone in 1987.

Mitsubishi

Positioning themselves perfectly for a free-for-all market, Mitsubishi has a complete line spanning econobox to luxury sedan. The Colt has been revamped into the Mirage, with a very European-style body that's similar to the Impulse.

At Dodge and Plymouth dealers, the Mirage will still be called Colt. Our test drive in the turbocharged version

showed this to be one of 1985's most desirable pocket rockets. The Colt Vista van/wagon remains an exclusive for Dodge and Plymouth. The only thing missing is the Twin-Stick, replaced with a conventional five-speed overdrive in all the small Mitsubishi.

The now-familiar Tredia and Cordia sedans have only minor trim changes, as does the Starion (called Conquest at Dodge/Plymouth). Electronic instrumentation, radio controls on the steering wheel, climate control and 15-in.

wheels are the big news.

Mitsubishi's big excitement is the Galant four-door luxury sedan. It has a 2.4-liter Silent Shaft engine, front-drive, electronically controlled automatic transmission and suspension, and every bell and whistle imaginable.

Nissan

Aside from new aerodynamic flush headlamps, the inexpensive Sentra, sporty Pulsar and compact Stanza are just the same as last year. So are the 200SX and 300ZX sports cars, except for minor trim and paint changes.

Obviously, Nissan's energy has gone into the all-new Maxima, and it's a beaut. The new Maxima looks similar to the old one, but beneath that conservative shape lurks the 3-liter V6 from the 300ZX. This has been popped into a new front-wheel-drive chassis. It's got everything: power, performance, handling, luxury, style. Factor in the surprisingly low price and you've got one of the best all-around sports sedans on the market.

Subaru

The bottom line Hatchback and Brat

1985 IMPORT CAR BASE PRICES

ALFA ROMEO

The Graduate	\$13,945
Spider Veloce	\$16,500
GTV-6	\$16,995

ASTON MARTIN

Vantage/Volante	\$110,000
Volante Convertible	\$125,000
Legonda	\$150,000

AUDI

4000S	\$13,950
Coupe GT	\$15,250
4000S Quattro	\$17,450
5000S	\$17,710
5000S Wagon	\$18,920
5000S Turbo	\$22,875
Quattro Turbo	\$35,000

BENTLEY

Mulsanne	\$97,950
Mulsanne L	\$108,390
Continental Convertible	\$155,470

BERTONE²

Bertone	\$9,995
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BMW

308i	\$16,430
325i	\$20,970
528i	\$24,565
535i	\$30,760
735i	\$36,880
635CSi	\$41,315

CHEVROLET

Sprint	\$6,151
Spectrum Hatchback	\$6,295
Spectrum Sedan	\$6,575

DODGE/PLYMOUTH

Colt	\$5,372
Vista Van Wagon	\$6,721
Conquest	\$12,564

FERRARI

308GTB	\$54,300
308 Spider	\$59,500
Mondial Quattrovalvole	\$59,500
Mondial Cabriolet	\$65,000
Testarossa	\$87,000

HONDA

Civic Hatchback	\$8,399
Civic CRX Si	\$14,479
Civic CRX Si	\$17,000
Civic Wagon	\$17,195
Civic Sedan	\$17,295
Accord Hatchback	\$17,895
Accord Sedan	\$18,845
Prelude	\$10,345

IAI

Yugo 55	\$3,990
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ISUZU

1-Mark Deluxe	\$6,785
Impulse	\$11,048

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Subaru

The bottom line Hatchback and Brat

JAGUAR

XJ6	\$32,250
Vanden Plas	\$35,550
XJ-S	\$36,000

LAMBORGHINI

Jaipa	\$53,000
Countach	\$99,500

LOTUS

Espit Turbo	\$48,739
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MASERATI

Biturbo	\$25,945
Quattroporte	\$66,210

MAZDA

GLC	\$5,195
626	\$8,485
626 Coupe	\$8,845
RX-7	\$10,945
RX-7 GS, SE	\$15,645

MERCEDES-BENZ

190E	\$22,850
190E	\$22,930
300D	\$31,940
300CD	\$35,320
300TD	\$35,510
300SD	\$39,500
380SE	\$43,330
380SL	\$44,420
500SEL	\$52,200
500SEC	\$57,800

MITSUBISHI

Mirage	\$5,389
Tredia	\$6,339
Condia	\$8,449
Tredia Turbo	\$9,279
Condia Turbo	\$9,959
Galant	\$11,989
Stanion Turbo	\$12,629

MERKUR

XR-4Ti	\$16,503
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NISSAN

Sentra	\$5,499
Sentra MG	\$7,099
Sentra Wagon	\$7,349
Pulsar NX	\$8,249
Stanza	\$8,949
200SX	\$8,999
Maxima	\$14,399
Maxima Wagon	\$14,399
300ZX	\$17,199
300ZX Turbo	\$19,699

PEUGEOT

505GL	\$11,900
505GL Wagon	\$12,400
505S	\$15,580
505 Turbo	\$18,150

PININFARINA²

Spider	\$16,999
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¹ See Rolls-Royce in text. ² See IAI in text.

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Subaru

The bottom line Hatchback and Brat

PORSCHE

944	\$21,440
911 Carrera	\$31,950
928	\$44,000

RENAULT

Puego	\$9,295
Sportwagon	\$9,895

ROLLS-ROYCE

Silver Spirit	\$98,500
Silver Spur	\$109,000
Camargue	\$150,600
Corniche Convertible	\$156,000

SAAB

900	\$11,850
900S	\$15,040
900 Turbo	\$18,150

SUBARU

Standard Hatchback	\$5,118
Hatchback	\$7,053
DL	\$7,463
GL	\$8,013
DL Wagon 4WD	\$8,073
GL Wagon 4WD	\$8,563
GL Sedan 4WD	\$9,233

TOYOTA

Tercel	\$5,348
Tercel Wagon	\$6,918
Corolla Sedan	\$6,938
Corolla Five-Door Hatchback	\$7,198
Terzo Wagon 4WD	\$7,898
Corolla Sport	\$8,058
Camry	\$8,449
Camry	\$8,948
Corolla GT-S	\$9,298
Van	\$9,748
MR2	\$10,999
Celica GT-S	\$11,199
Cressida	\$11,590
Cressida Wagon	\$11,750
Celica Supra	\$15,998

VOLKSWAGEN

Golf	\$6,790
Jetta	\$7,775
Jetta GL	\$8,495
Golf GTI	\$8,990
Scirocco	\$9,980
Quantum Wagon	\$11,570
Cabriolet	\$11,595
Vanagon	\$12,290
Quantum GL	\$13,295

VOLOVO

DL	\$12,940
DL Wagon	\$13,415
GL	\$15,965
GL Wagon	\$16,515
Turbo	\$18,420

WILLYS

Wagon	\$8,950
740 GL	\$10,445
740 Turbo	\$11,045
760 GL	\$12,485
760 Diesel	\$22,170
760 Turbo	\$22,625

are unchanged, but there's a whole new look at Subaru for the rest of the line. The four-door sedan and station wagon have been restyled with flush aerodynamic headlamps. The chassis is similar to earlier models, though the 1.8-liter flat Four now has an overhead camshaft for each bank of cylinders.

There's a turbo version as well as four-wheel drive. New this year is an electronically adjustable suspension on 4wd models that automatically increases ground clearance at low speeds. Despite the complexity, we've found the system to be completely reliable over several thousand miles of test driving. This spring, Subaru will present a Prelude-like two-door sports coupe based on this new chassis. There even will be a genuine two-seater, as well as a 2+2.

Toyota

While other companies proudly present one new model, Toyota has three. The Starlet has been dropped, while the Van, Tercel, Camry and Corolla remain essentially unchanged.

New this year, however, is a 16-valve head for the 1.6-liter Four. This is rated at 112 hp, and when slipped into the cute little Corolla Sport Coupe or Liftback, it makes a mini hot-rod along the



TOYOTA MR2 is an all-new mid-engine two-seater that uses the 16-valve Four.

lines of the Mirage Turbo. The Corolla GT-S has four-wheel disc brakes, fat tires on 14-in. wheels and truly zappy tape stripes.

Toyota's second new sports car is the MR2, which uses the Corolla GT-S engine placed behind the seats in a Fiero-like two-seater. The MR2 is smaller and lighter, not as pretty and about the same price. Of course, Toyota still has the excellent Celica—now with more horsepower and a convertible option—as well as the thundering Supra for lovers of traditional GT coupes.

At the top of the Toyota line is the fabulous Cressida, in effect a four-door Supra. With a 2.8-liter dohc Six, four-wheel discs and stiffish suspension, it makes a world-class sports sedan and, unfortunately, one that was not yet



SUBARU adds self-adjusting electronic suspension to its four-wheel-drive models.

available when we did our sports sedan test. For 1985, the Cressida has slightly more horsepower, rack and pinion steering, electronic instrumentation and an all-new body that looks much like the old one—boxy and conservative.

EUROPEAN CARS Alfa Romeo

Alfa continues to sell two sports models in the United States, the GTV6 coupe and the top-down Spider. Sometime before the end of the year, there will be a GTV-6 with twin turbochargers à la Maserati's Biturbo. Expect it to cost upwards of \$25,000. At the other end of the Alfa scale is The Graduate, a bargain-priced \$13,000 version of the venerable Spider.

Aston Martin Lagonda

There are three Aston Martin models—the base V8 Coupe, the hot-rod Vantage and the sleek convertible. Prices start at \$110,000, and all three are unchanged again this year. The \$150,000 Lagonda is a four-door sedan with needle-nose styling.

Audi

The Audi 4000 line has been significantly restyled for 1985, along the aero lines popularized by the big 5000S. The neatest 4000 is the Quattro, a four-door sedan with the five-cylinder engine from the 5000S, plus full-time four-wheel drive. For less than \$17,000, it's a bargain in the sports sedan market.

Meanwhile, the regular 4000 and Coupe GT have been given a new five-speed gearbox and updated interior that's friendlier than last year's taxicab treatment. The only change to the

5000S is an increase to 2.2-liters for normally aspirated engines.

BMW

The best-selling 318i and 325e are now available as four-door sedans, the first small BMW four-doors in nearly two decades. Cleverly, the change is made simply by shifting the B-pillar forward and adding small rear doors. The rest of the car is unchanged. The 528e also remains the same.

The biggest BMWs—the 535i sedan, 635i coupe and 735i sedan—now sport 3,428-cc Sixes rated at 185 hp and ABS antiskid brakes. This puts them right at the top of the luxury sedan ranks when it comes to performance, safety, status and, of course, price.



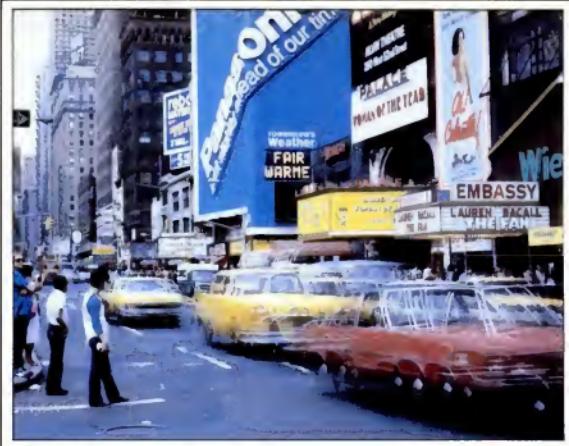
VW JETTA gets a soft-edged facelift, and the GLI option gives it sporty character.

Ferrari

Ferrari means sports car to most people, a reputation that's totally justified. The 308 GTBi coupe, 308 Spider, Mondial and Mondial Cabriolet are all unchanged for the foreseeable future.

For the first time in a decade, the big 12-cylinder Ferrari Boxer will be U.S. legal starting next fall. Restyled to accommodate midships radiators and re-

(Please turn to page 147)



Most professional photographers use special effects to enhance the impact of the scenes they shoot. Many are within the capability of the amateur. The four effects here vary in complexity, but are easy to accomplish without sophisticated cameras. Two, in fact—reflective distortion and panning—can be done with auto-everything compact cameras. Unless stated otherwise, you can use any type of film.

DRAMATIC

SPECIAL EFFECTS

TEXT AND PHOTOS BY ARMAND ENSANIAN

1 Drop-shutter

To create this effect, you need a shutter that opens and closes in a rapid sequence. It's easy to build. Bolt the camera on a board using the tripod mount. Cut $2\frac{1}{2}$ -in. holes in each side of a black plastic or cardboard box, and $\frac{1}{8} \times 4$ -in. slits in the top and bottom. Attach this box to the board so that the camera lens fits within the hole and the slits extend beyond the board's edge. For the dropping part of the shutter, use heavy black cardboard $3\frac{1}{2}$ in. wide \times 2 ft. long. In both directions from the center, cut $\frac{1}{16} \times 2\frac{1}{4}$ -in. slits widthwise: either four slits 3 inches apart, or five slits 4 inches apart. Top and bottom should be unslit so that the lens is covered completely before and after dropping. Glue a stop block near the top. Before shooting, focus and compose as usual, then insert the shutter slide.

To make the exposure, cover the lens with the unslit portion of the slide, open the camera shutter (on B if adjustable), drop the slide shutter and close the camera shutter. The slide should fall rapidly. The total exposure from four slits will be approximately $1/250$ sec. Experiment with various slit numbers, widths and spacing. For best results, use 100 ASA film at f/8.



Effect No. 1—Drop-shutter technique, seen above and at left, gives dynamic fast-frame realism to otherwise static pictures. Photo at far left shows PM's homemade drop-shutter. All that's needed is a small wooden board, 2-foot cardboard strip and box. A camera tripod is optional for this and other special effects, but is recommended for stability.

2 Reflective distortion

For surrealistic pictures of landscapes or small objects, try photographing the reflected image off of a piece of mirror-surface Mylar that has been mounted on a board.

Keep in mind that the camera has to be focused on the actual image reflected through the Mylar—not on the Mylar board itself. So, with auto-focus cameras, it's important to lock the focus on the actual distance between the Mylar surface and your subject.

3 Double exposure

The two women pictured here aren't twins. This is a multiple exposure of the same model made on one frame of film, and it can be done with almost any camera that has a manual rewind crank or multi-exposure switch. Each half of the picture was exposed separately, using a simple cardboard divider in front of the lens, mounted on the lens shade or skylight filter. Compose and focus on a setting or location which allows at least 2 ft. of space between the spots where you plan to place the model. Take your meter reading without the divider.

Mount the semi-masked lens shade or skylight filter, pose the model in front of the open side of the lens and shoot.



Effect No. 2—An inexpensive piece of mirror-surface Mylar, available at most art supply or stationery shops, is all that's needed to create the surrealistic photos seen above and at far left. Mylar's uneven surface distorts the reflected image with an undulating ripple pattern. At immediate left, the camera is focused on the reflection within the Mylar—it should not be focused on the Mylar board itself.

Carefully rotate the divider 180°. Hold the rewind knob snugly to prevent the film from moving, depress the rewind release button, and recock the shutter with the film advance lever. Reposition the model to the other side and shoot. Advance the film normally to the next frame.

Effect No. 3—For multisubject double exposure, as seen below, a degree of double-jointedness is helpful. At right, photographer depresses the rewind-release button, then holds the rewind crank snugly while recocking the shutter with the film advance lever.



4 Panning

This is a simple technique that emphasizes motion and speed. The idea is to move the camera with the subject, causing the background to streak. To do this, prefocus the camera on the spot directly in front of you where you expect the subject to be when you shoot. Set the shutter speed according to the guidelines given below. Through your viewfinder, compose the subject and monitor it as it approaches—but don't refocus. Release the shutter just as the subject comes directly in front of you—and keep the camera moving to follow through. When shooting subjects up to 20 feet away, match your shutter speed to the subject's speed: $1/8$ sec. for up to 20 mph; 20-40 mph, $1/15$ sec.; 40-60 mph, $1/30$ sec.; $1/60$ sec. up to 100 mph. With nonadjustable automatic cameras, use ASA 25 film. **PM**



Effect No. 4—Timing's critical for panning shot seen above. Release shutter when the subject is in focus, then follow action.



GREAT MOVES OF HISTORY

Through eons man has learned how to move mountains overnight.

The statues stand as tall as 9 feet and weigh as much as 24 tons. They were carved out of volcanic rock and transported 50 miles across heavily forested land by the Olmec Indians of Mexico 2,000 years before Christ was born. Their travels should have left scars in the earth, but aerial photographs have not located any. Much of the journey was carried on away from water, yet the Olmecs had no wheel to handle the overland portion of the trip. Nor did they use beasts of burden.

"The mystery of the Olmecs lies buried in 4,000 years of history. Our best guesses as to how they accomplished this feat must come from studying ancient moves in a better documented part of history." That conclusion was drawn in a paper presented at the American Association for the Advancement of Science meeting in New York last year. The better documented moves give us a staggering picture of man's constant striving to tap the forces of nature, giving him the power to perform amazing moves.

To appreciate how far back this branch of engineering goes, you might well look over the shoulder of Domenico Fontana, whose job it was to move an 80-foot-tall stone obelisk weighing almost 400 tons about a half mile across Rome in the 16th century. Before designing the moving tools, Fontana studied how the ancient Romans had moved the Obelisk from Memphis in Egypt to the Circus Maximus before 300 A.D. Systems of ropes, pulleys, blocks and tackles, inclined planes and playout wheels or capstans were used to build what amounted to a giant lever powered by men and horses.

It took Fontana a year to set up the move from Circus Maximus to St. Peter's Square. He had a giant hole dug in the center of St. Peter's Square. In the center of the hole, he erected a timber support structure to serve as a base for the obelisk after it was set upright. On the other side of town, Fontana had workers build a timber collar around the obelisk from its base to just below its top.

The collar sported a series of pulleys that would act



ILLUSTRATION BY DAVID BLOSSOM

as the block and tackle mechanism. Workers dug around the obelisk until it could be pulled down on the block-and-tackle system by the team of men and horses. It was set atop a series of giant log rollers. The team of horses and men pulled 160 ropes to slowly lower the tower onto the rollers. Then, they pulled the

Writer: Dennis Eskow, Science Editor
Reporters: Ellen and Jack Messmer, Washington;
Fran Wenograd Golden, Cambridge, Mass.; Jake Turkell, Tokyo



Block-and-tackle arrangement raised the obelisk on a ramp supported by a heavy timber structure. Ropes ran to captains below the tower.



THE GREAT OBELISK

Domenico Fontana commanded a team of 900 men and 140 horses to lift an 80-foot, 400-ton obelisk into the vertical position. The 16th century move in Rome's St. Peter's Square called for the raising of a wood tower and ramp system with the ramp's weight and later the obelisk supported by a heavy timber stand. A rope block-and-tackle system pulled the stone monument erect.

GREAT MOVES

obelisk along the avenues of Rome on the logs. Every few feet, the team had to stop so new logs could be slid under the monument as rollers slipped away.

In St. Peter's Square, meanwhile, Fontana had the timber support structure packed in earth. Then, he built an inclined plane that would allow his men to pull the obelisk up to the tower that would be used to set it upright.

Once set under the tower, the obelisk stood in place for several weeks as the ropes from the pulleys on its collar were threaded through pulleys on the arch of the tower. Those ropes were then played out to the capstans.

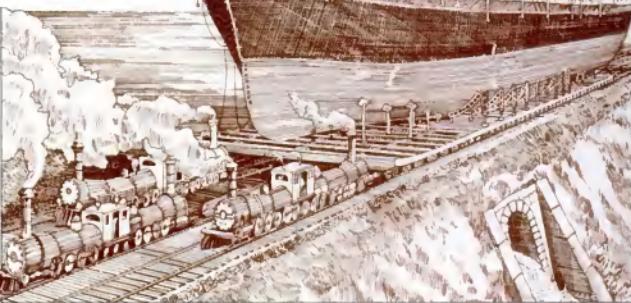
On the big day, Fontana assembled his company of men and horses and waited as foremen brought the group to near silence. At the sound of a trumpet, men and horses pulled on the ropes and the block-and-tackle system to convey that power to the horizontal monument. At the sound of a gong, the team stood in place. Then, another trumpet blast and then they pulled again.

Historian George Sarton says it took the work crews close to 12 hours to right the obelisk. The inclined planes were removed. Then, earth was packed around the base of the obelisk and the tower was dismantled. The obelisk stands, today, as a monument to the earliest engineers.

Fontana learned how to rig a tower from the Romans, who had copied the

INTEROCEANIC SHIP RAILWAY

While others were building the Panama Canal, James Eads began building a cross-Panama ship railway. Eads died before it could be completed.



Egyptians. The Egyptians had built such structures from cedar beams 3,500 years before Fontana. The Egyptians, archaeologists believe, also inspired Fontana's block-and-tackle system and perhaps even the inclined plane.

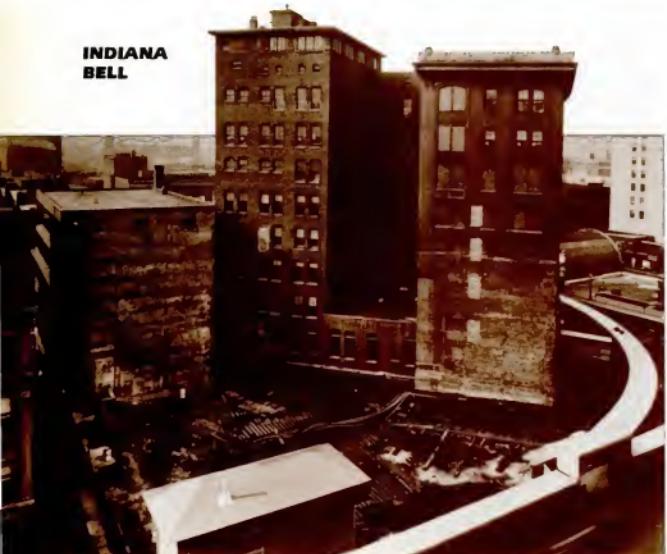
For the Egyptians and their Babylonian neighbors of 5,000 years ago, moving cut stone apparently was an almost routine matter. The Egyptians are thought to have taken from Babylonian engineering the design of a sluice-

way to channel Nile River water to the quarry and then to the site of the monument under construction. Giant stones were cut. Then ropes were lowered from the cedar towers, tied around the stones and tightened. With the stones raised, slaves pushed them so they swung out on suspended wooden arms. The stones were pushed to the sluiceway, set atop barges and shipped to the construction site, where the process was reversed.

Water's buoyancy has played a major role in the greatest moves of history. By the 19th century, one obelisk was moved from Rome to New York City over the Atlantic. And in the 1870s, civil engineer James Eads had a notion water could provide a shortcut through the Panama isthmus. His plan would save ships the time and trouble of going around South America to get from the Atlantic to the Pacific. And we're not talking about the Panama Canal.

A scientific journal in 1884 reported that Mr. Eads "has begun construction of an amazing rail boat system that will carry steamships by rail from the Atlantic to the Pacific over the Panama isthmus."

INDIANA BELL



Indiana Bell moved an eight-story, 11,000-ton office building on iron rollers 152 feet in 1930. It was jacked up off the ground.

COURTESY INDIANA BELL

mus." Other engineers were in the midst of survey work for the Panama Canal, but Eads convinced a contingent of Congressmen that the rail boat would be easier to build, cheaper to operate and easier to defend.

On the eastern end of the isthmus, he constructed a mile of rail that led to the ocean. There, a ship could be raised out of the water and set on rails. Eads constructed a pump station and an oak cradle shaped like a sling. When a ship entered the rail connection point, water would be pumped out of a man-made lagoon and the ship would sit atop the cradle, which had railroad car wheels.

Water pumped out of the lagoon would be shunted to the hydraulic pumping system that lifted the cradle and boat out of the shallow lagoon to the track level. A locomotive on each of two parallel tracks would then be hooked to the cradle.

Eads built a small demonstration cradle on which he lifted a yacht in 1886. He was able to roll it down the rail for about a mile, demonstrating the feasibility of his design. Congress haggled over the idea for another year. The following year, Eads died and his wife took over his construction company. She simply wasn't up to the job, and the company quickly went bankrupt.

Less than a century after Eads' death, water again became the major lifting device for a great move. Perhaps the greatest in engineering history.

The Jari company, a giant in wood and paper products, wanted to set up a

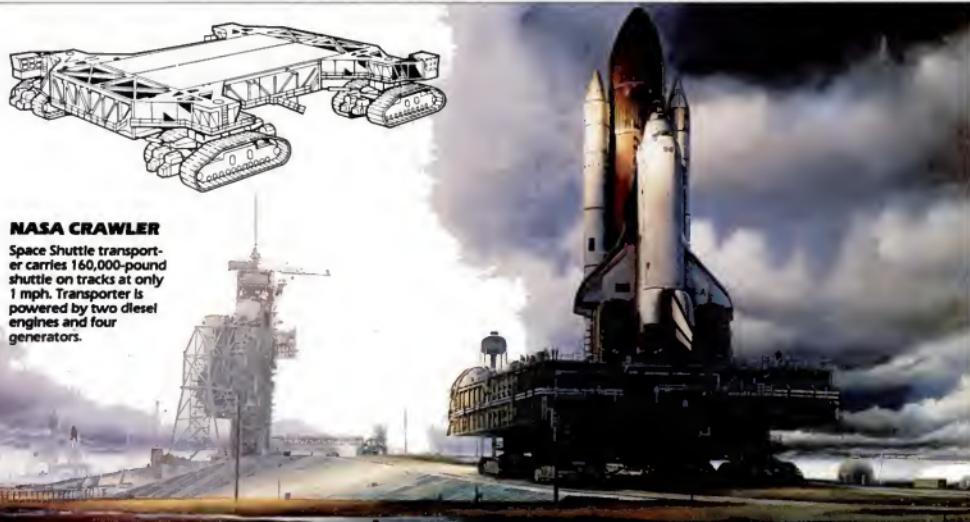


pulp plant near the jungle along the Amazon River in Brazil. The location was perfect for paper processing, easily accessible to the ocean and to the trees needed for manufacturing paper. But, there were no facilities to carry building supplies through the jungle to construct the giant factory and a power plant.

Daniel Ludwig, head of Jari, decided to import an entire paper mill and power plant from Japan. Working with IHI, the Japanese construction firm, Ludwig and his Brazilian partners de-

signed a modular plant that could be built in dry dock atop a barge. Elements of the two plants would be built one at a time at dockside, then raised into position atop a barge. Eventually, the entire two-barge system—one carrying the pulp plant, the other the power plant—was towed 15,000 miles from Japan to Brazil. The plants were towed up the Jari River, an Amazon tributary. Foundations and support structures had been built and flooded to allow the

(Please turn to page 132)



NASA CRAWLER

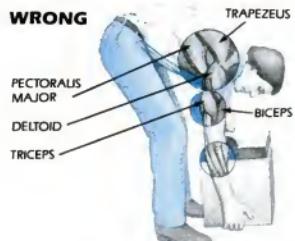
Space Shuttle transporter carries 160,000-pound shuttle on tracks at only 1 mph. Transporter is powered by two diesel engines and four generators.



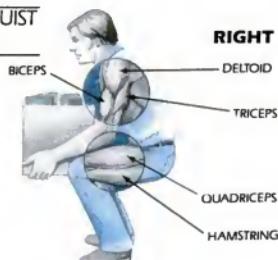
INSIDE MOVES

If you've ever pulled a muscle or injured your back moving objects around the house, you need these tips.

BY LEE GREEN AND PAUL STENOQUIST
Illustrations by Bryce Lee



Most muscle tears and back pulls happen when a heavy object is lifted straight up, placing all the strain on the lower back and upper arm muscles [left]. By squatting down and picking up the object at the bottom forward end [right], the arm acts as a lever and larger thigh muscles help distribute the load evenly and safely.



A healthy 6-foot man exerts 2,000 pounds of force to lift a 200-pound object from the floor to chest level. It may not be a superhuman feat. But physical forces involved in such a move have sent an estimated 250,000 Americans to the doctor every year. Thanks to man's early struggle with moving large objects (see *History's Greatest Moves*, page 100), we've learned that simple tools—levers, wheels, rollers, inclined planes and pulleys—can make the job survivable, if you do it right.

We developed our tips with the advice of surgeon John P. Cossa, M.D., of St. Agnes Medical Center in Philadelphia, and chiropractor Paul A. Muscolino of Scarsdale, N.Y.

Before you set out to move heavy boxes, appliances or furniture, do warmup exercises. Five minutes of bending and stretching, jumping jacks and situps may make you feel

self-conscious. But warming up will prevent about 20 percent of muscle injuries reported in household moves.

Most muscle tears and back pains come from positioning yourself incorrectly before you lift. To pick up a heavy box, for instance, most of us simply bend over, place our hands under the object and heave ho. For better load distribution, squat in front of the box and place your hands under it as far forward as you can reach comfortably. Now the arms are being used as levers and the large thigh muscles are taking a big share of the load.

Moving a large appliance is the next biggest cause of muscle injury. The most common mishaps occur with refrigerator moves. If your refrigerator is on casters, all you have to do is pull up rugs along the route of travel or lay down skids in the form of wood boards or linoleum strips.

How To Move A Refrigerator/Freezer



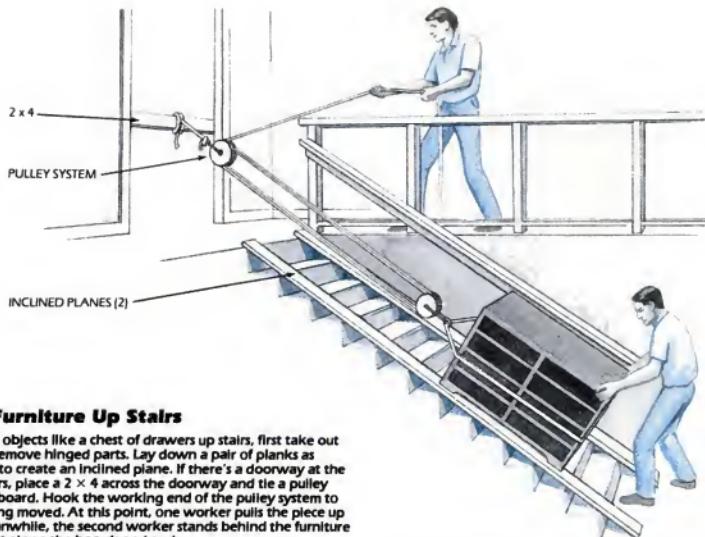
To move any large object without casters, cut a set of rollers from 3-inch dowels or PVC pipes [metal pipes damage floors]. Tip object and set one dowel underneath. Push at top and set dowel with your foot.



Slide a sheet of plywood underneath the tipped object. The first roller or dowel you inserted will help make way for wood sheet as you push it about two-thirds in. Slip three dowels under the wood sheet.



With dowels oriented in the direction you want to go, slowly roll the object forward. Just as the rear roller is about to be left behind, you should insert a spare roller under the leading edge of the refrigerator.



Moving Furniture Up Stairs

To move large objects like a chest of drawers up stairs, first take out drawers and remove hinged parts. Lay down a pair of planks as shown above to create an inclined plane. If there's a doorway at the top of the stairs, place a 2×4 across the doorway and tie a pulley system to the board. Hook the working end of the pulley system to the object being moved. At this point, one worker pulls the piece up the stairs. Meanwhile, the second worker stands behind the furniture to help guide it along the boards and push.

But, if the refrigerator has no casters, you might want to set up a roller system.

You'll need several sections of 3-inch dowels or PVC pipe, and a sheet of plywood the width of the appliance. The rollers should be at least 2 feet long. Tip the appliance and set one dowel underneath so the object you're moving is in a slightly tipped position.

Next, push the plywood board under the appliance about two-thirds of the way. Spread three dowels evenly under the plywood. Go to the other side of the appliance and start pushing gently. As you move, rear dowels will fall out and you'll want to replace them up front.

There also are a range of hand trucks and dollies designed especially for household moves. We've developed two useful and easy to build household moving devices (see

box on page 106), should you want to make your own.

The next biggest cause of moving injuries is improper moving of large objects up stairs. You can make the task even more painless with the help of a pulley system, a 2×4 , a pair of planks and a length of rope.

Whatever the object, remove all hinges, drawers and contents before starting upstairs. Lay the planks on either side of the stairwell up the full length of stairs. Set the 2×4 in a doorway at the head of the stairs. It serves as the anchor for your pulley system. If there's no door, you'll have to find a place to fasten a block and tackle or garage ratchet hoist a couple up feet in front of the upper landing. Hook the working end of the lever and pulley system to the object being moved.

Setting up is a one-man job, but moving large objects up stairs is really a job for two. The stronger worker should be at the top of the stairs, pulling the rope. The other mover should stand behind the furniture, slightly bent over and pushing to make sure the object stays on the planks.

Carrying boxes over long distances, and especially up stairs, is almost always done the wrong way, according to our medical consultants. Most of us place a handle or rope on the box and pick it up with one hand, shifting hands as we go. This constant shifting causes a heavy strain on the latissimus dorsi muscles, leading to upper back strain.

By packing two (or more) boxes with even weight distribution and tying them with a handle or length of rope at the top, you can set yourself up for a more healthy moving experience. Lifting a box with each arm will distribute the weight across the thick and strong abdominal rectus muscles around the stomach. The even weight distribution

Carrying Boxes Over Distances



The key to any successful moving project is proper weight distribution. A major cause of injuries is the one-handed method of carrying boxes and other heavy objects. Switching the box from hand to hand strains the latissimus dorsi—a major cause of upper back pain. By carrying two boxes of about the same mass by a handle or rope, the strong rectus abdominis muscles help distribute the weight, taking strain off back.

INSIDE MOVES

might feel like extra weight, but that's more of a state of mind than anything else. The evenly distributed weight will place far less strain on any individual muscle than will the shifted weight of one box.

Most moves around the garage are pretty straightforward. But there's one trick that you might find helpful.

If your car dies on the street near your driveway and the conditions are right, you can singlehandedly tow it off the street using a floor jack.

Because floor jacks are fitted with swiveling platforms and caster-type rear wheels, the device can be used to dolly a car out of the street. Move carefully, watching for any movement of the jack away from the jack point. If the driveway is walled off, you also have to be very careful not to get sandwiched between the car and a wall.

A car can be moved with a floor jack from the front or the rear, but the front pulling method is best. Set the jack under the centermost part of the jackpoint and point the jack handle in the direction you want to go. Now, jack up the car just enough to get the tires off the road.

With the brakes off and the car in neutral, slowly and carefully pull on the handle. You should not have to bend so low that your head is below your waist, nor should you have to rock back on your heels more than a fraction of an inch. Otherwise, you'll tear at an array of mus-

cles including all the back muscles, the triceps and the lattissimus dorsi.

If the car starts rolling so fast it can't be stopped by pushing forward on the jack, lower the jack so the wheels touch the ground again. Moving a car like this should never be performed unless you have a fairly level driveway with arms-length clearance from any walls.

Moving heavy objects around the home, shop and garage is something most of us do at least a couple of times a month. You may not have to perform any of the specific tasks we covered here, but the general principles apply.

- When lifting heavy objects, keep them close to your body. This provides balance and weight distribution.
- Always try to put most of the load on your leg and thigh muscles. They are stronger than any other muscle set and relying on them will take most of the weight off your back.
- Plant your feet close to the object being lifted to ensure greater reliance on leg and thigh muscles.
- Wear a thick, heavy belt (sacroliliac belts are available at most medical aid shops) when lifting.
- Work with rhythm.

■ Always warm up before working. Take breaks, since working when fatigued causes muscle damage. Dress comfortably for the work, and protect yourself from drafts.

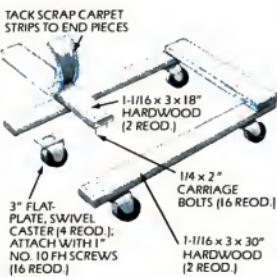
Finally, set up any moving job with an advance plan. It's best to walk through the move with a tape measure in hand before starting. If you have to stop in the middle, you'll lose the advantage of the warmup and injury may result. **FM**

Moving A Stalled Car With A Jack

A good service jack will save a whole range of back and arm muscles in moving a stalled car. Most people try pushing the car off the street. It's better for your body to place the service jack under the forward jack points as close to the center as possible. Set the jack with its handle facing the direction you want to go. Slowly, and only slightly bent over, raise the wheels just a fraction of an inch off ground and pull. If car rolls fast, lower jack.



Two Easy-To-Build Moving Aids



Two of the simplest—but most useful—moving aids can be built for a minimum outlay of cash and time, and provide years of faithful service in the bargain. The dolly on the left is made of solid hardwood stock with its end pieces covered by carpet so you can move furniture on any side without damaging the finish. The handy panel grip shown on the right will save countless backaches if you frequently carry large sheets of plywood, particleboard or drywall. To use it, just tip up the panel, slide the hook under the bottom edge and lift. Use your free hand to stabilize the panel.





How To Move A Baby Grand

You'll need a rolling pin, a large stack of books and a teen-ager to do this job the right way.

BY VICTOR BORGE
PM Music Critic

ILLUSTRATION BY JACK DAVIS

Reflecting on certain episodes from my childhood, I find a few that were strange, if not bizarre. For instance, my father, a musician in the orchestra of the Royal Opera House in Copenhagen, each evening before leaving for a performance, wanted a soft-boiled egg cooked for exactly three minutes. To make certain that the egg was neither over- nor undercooked, I was assigned to play Chopin's *Minute Waltz* three times! The only problem was getting the piano in and out of the kitchen every night.

Naturally, I'll let you choose whether to believe that or not. But about the following story, I offer you no choice.

I often watched my mother making Danish butter cookies. And what, you may ask, does that have to do with moving pianos? Nothing, except the eminent importance of one of the weapons she used in doing it.

In our living room, we had a well-used but fairly good upright piano at which my mother taught a small number of students. It was the instrument at which, during my school years, I had to practice at least three hours daily. I was jubilant when my maternal grandmother had a beautiful 7-foot baby grand piano delivered on my 15th birthday. The four husky piano movers who brought it were kind enough to roll the old upright out of the living room, through the dining room and into my own room.

But my grandmother felt that I was the one who deserved the baby grand. So, after a friendly family debate, my parents agreed: The baby grand should go to my room, and the old upright should return to its previous spot.

The four men were summoned and scheduled to do the moving right away. At that time every home in Denmark, I



thought, must have had a piano or two delivered, for weeks went by and the movers still didn't show up.

One Wednesday night I went to bed about 10 o'clock, as did my parents. But I couldn't sleep. How do you get a 4 1/2-foot-wide baby grand through two 3 1/2-foot-wide single door frames and across two thresholds without a sound?

Grinding each detail through my mind, I concluded that indeed it would be possible to move the mammoth instruments if only I could find my mother's rolling pin.

Here's how it's done if father's study is in the next room and mother's rolling pin is readily accessible:

1 Push the piano as close to the first threshold as possible. Remove every removable article (including hinges) from the instrument—lid, lyre to which the pedals are attached and the entire keyboard.

2 Get on your knees under the instrument and stack books near each leg. Then, lift, place a book, lift, place a book, until there is enough clearance to unscrew and remove the three legs, one at a time, of course.

3 Now, reverse the procedure by removing a book at a time at two of the legs. The rolling pin, wrapped in a couple of towels, must be placed about 2 1/2 feet from the threshold so that the piano, when turned on its side, will overlap at least 1 1/2 feet.

4 You may now push the instrument slowly and soundlessly across the first threshold. Be sure that you provide adequate height of books to allow replacing the rolling pin for the trip to-

ward and across the next threshold!

Fortunately, we did not have wall-to-wall carpeting. The polished dining room floor was as smooth as a skating rink, and with the help of a few towels the big boy slid comfortably across our dining room.

After entering its resting place, the piano now has to be rehabilitated—getting back on its legs! This obviously is achieved by reversing the procedure.

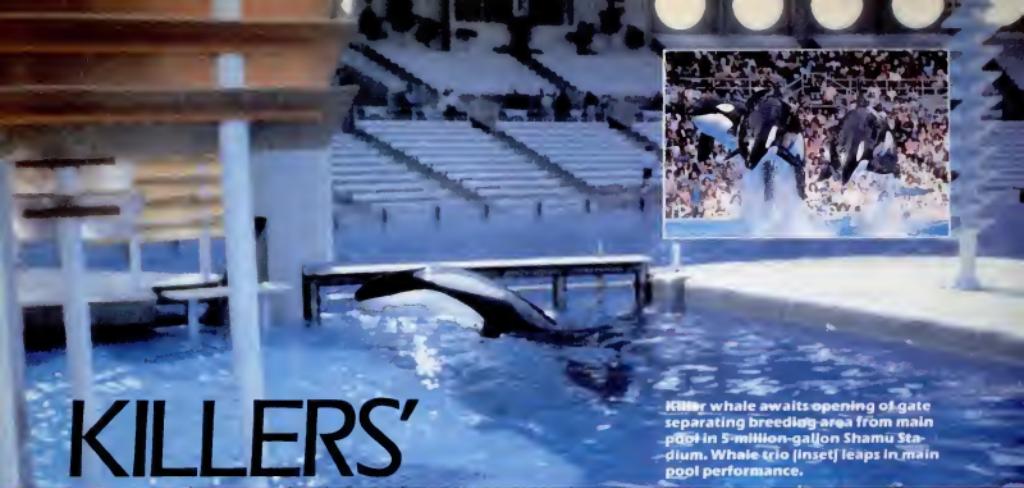
Now, the upright had to be moved back to the living room. By lifting and pulling, lifting and pushing again and again, the faithful upright finally rested in the place from which it never should have been removed.

And so, without a scratch on the baby grand, the upright and any floors, I fell into bed shortly before 7 o'clock. It was almost daylight, and precisely as I turned off the bedlamp, my mother entered the living room.

Would you believe she didn't notice? So accustomed to seeing the old upright where it belonged for years, my mother didn't realize the changes until half an hour later, when she wondered why I wasn't up yet and entered my room to awaken me.

I realize that you may not believe this. My mother didn't, yet she was there and saw it!

But please take my word for it, for, as Hans Christian Andersen wrote: "It's perfectly true." From then on, my mother slept even lighter, from fear that perhaps one morning she wouldn't be able to locate the kitchen.



KILLERS' HIGH-TECH HAVEN

Finally, we have the right knowledge and habitat to breed killer whales in captivity.

BY DENNIS ESKOW
Science Editor

The killer glided swiftly through the chilly water, coming at us like a huge torpedo. As he approached, we jumped away from the water's edge. But the half-ton monster leaped out of the water and skidded onto the cement.

"They called this whale a killer long before we knew much about him," said Dave Butcher, director of Animal Behavior for Sea World. But he emphasized that killer whales are friendly—they like trainers to scratch their backs—and extremely docile.

Dozens of marine biologists had come to mark the opening of Shamu Stadium at Sea World in Orlando, Fla. The \$15 million, 3.5-acre pool housing three killer whales is about to revolutionize the ocean sciences.

No killer whale has survived birth in captivity. Until recently, scientists had no idea why. But extensive research with dolphins in captivity and with whales at sea has led to the answer. First, you need a pool large enough to provide private "family" living space. Shamu Stadium's pool holds 5 million gallons and is separated into several smaller pools by metallic gates. The

small pools will give killers privacy.

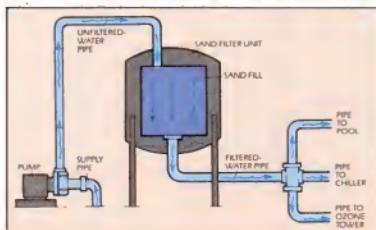
The tank's water is chilled to 55° F., and a special filtration system cleans out over 100 pounds of waste produced by each whale daily. The water is in a closed system, keeping it out of the Orlando water table. Chemically treated, it is pumped through sand filters. The cleaned water branches into three sections. One goes back to the pool. The other two go to a chiller system or an ozone stripping system that removes dirt and bacteria.



Like dolphins, whales are born head first. Sea World scientists in the 1970s discovered that dolphin families ran in threes, two females and a male. When one female gave birth, the other brought the baby to the surface for air and would nursemaid it.

Marine biologists have discovered that whales also travel in threes. And now Shamu Stadium is ready to receive a female with midwife experience. She will be captured later this year. Within five years, researchers hope to have bred the first killer in captivity. **PM**

PHOTOS BY STEVE ESKOW



Chiller tower [above left] circulates one-third of pool water to cool it to 55° F. Sand filters [right] remove hundreds of pounds of waste.

In Shamu Stadium, supply pipe of filter system (left) carries water from whale pool to sand filter. On leaving, water branches into three pipes—to the pool, to an ozone tower and to the chiller tower—before returning to whale pool.



The Phoenix clock not only has the look of sculptured art, it keeps accurate time—a real feat for clocks that have wooden movements. The timepiece will run 30 to 36 hours on a single winding.



The clock kit contains all necessary parts and finishing materials. Except for shafts and springs, all parts are of hard maple.

WOOD-SCULPTURE CLOCK FROM A KIT

The ultimate timepiece, this Phoenix clock is made almost exclusively of wood.



Proper sanding ensures accurate timekeeping. The kit includes strips of abrasive for hard-to-reach spots, and a sanding jig for gear teeth so the tooth profile remains unaltered.

The Phoenix grandfather clock is a work of art, the ultimate achievement in wood. Not only is it a fine piece of wood sculpture, it is functional as well. Made like a fine brass movement, it has the same timekeeping abilities.

The clock is the skeletal type, which means all its moving parts are plainly visible. It could be described as a piece of art in motion. The clock is offered in two kit versions: the Grandfather shown here, and a similar Grandmother clock which is slightly thinner from front to back. The kits include everything needed for the movements, including sanding jigs, fixtures, dye, glue, epoxy, sandpaper, gauges, finishing material, even plastic gloves.

The 76-page instruction manual is impressively thorough. It stresses the importance of sanding to obtain accurate timekeeping and a superb finish. So important is this step that 15 pages of the manual are devoted just to the sanding procedure.

The heart of the clock

The heart of the pendulum clock is the escapement—the part that controls the pendulum by movement of the notched escape wheel. A short course on the basics of this escapement mechanism is there for anyone interested in knowing more about how the mechanism works.

The intricate parts of the clock are machined to extremely close tolerances, a necessity if the clock is to function. To ensure that the parts maintain their

(Please turn to page 142)

Build Our ENGLISH GARDEN FURNITURE

Here is a quartet of solid teak outdoor furniture that would grace anyone's back yard, deck or sunroom.

BY NEAL BARRETT

The design of this garden furniture is based on the shape of the traditional park benches used in public gardens throughout England. These pieces are extremely sturdy and feature contoured seats, raked backs and mortise-and-tenon joinery.

They are also made of solid teak which is one of the most attractive and most dense hardwoods available. It is expensive, sometimes costing as much as \$10 per board foot, but you do get what you pay for. It possesses a very high natural oil content which makes the wood impervious to rot, even when continually exposed to the most severe weather conditions. These pieces can be left outside year after year and will require no maintenance or other precautions. And, over time, they will weather to a distinctive silver-gray color.

Because the resins in this wood can be an irritant to the respiratory system, it is advisable to wear a high-quality dust mask when making all cuts for this furniture.

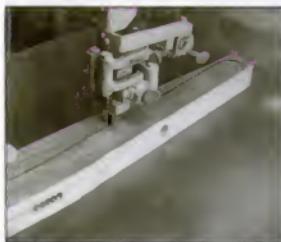
Black and white photos: Neal Barrett; **Technical art:** Eugene Thompson; **Color photo:** Paul Barton



Begin bench and chairs by laying out seat support and stretcher mortises on rear legs before legs are cut to shape. Bore overlapping $\frac{1}{4}$ -in.-dia. holes to remove waste.



Next, bore $\frac{1}{4}$ -in.-dia. hole at center point of armrest mortise. By boring this hole before rear legs are cut to shape, you avoid the need to cut an angled mortise later.



Transfer pattern shown on drawing to rear leg stock, then cut out finished leg using a band saw. Cut on waste side of line and use belt sander to remove saw marks afterward.



Made of solid teak, these four pieces of outdoor furniture are as durable as they are beautiful. All can withstand year-round exposure to the elements because of the wood's high natural oil content.



Cut the armrest tenons on the top of the front legs using a dado blade in a table or radial-arm saw. Use the same method to cut the seat support and stretcher tenons.



To ensure identical tenon depths on all similar parts, clamp stop block to saw table to act as alignment guide. Hold stock tightly against miter gauge while cutting.



Cut armrests to shape on band saw, then remove saw marks with belt sander and cabinet scraper. Ease edges—except back—with router and $\frac{1}{16}$ -in. rounding-over bit.

Chair and bench construction

The chairs and bench are for the most part identical in their construction. The only differences occur in overall length, in the spacing and number of slats in the backs of each, and in the addition of one rear support rail and two intermediate seat supports in the bench.

Begin construction by ripping stock to rough width and length for all chair and bench parts. Using a jointer, true one face and one edge of each piece; using a planer, surface the opposite face to the correct thickness for each part. Then, rip the parts to finished width on the table saw—except for the rear legs. Cut a $2 \times 4 \times 35$ in. blank for each of these and trace onto each the profile of the leg shown in the drawing.

Next, lay out the positions of all

mortises on the front and back legs. Then, bore overlapping $1/2$ -in.-dia. holes on the drill press to remove most of the waste from these mortises. It's a good idea to bore these holes $1/16$ in. deeper than the corresponding tenon lengths to allow room for glue to squeeze out. Also, bore a $7/8$ -in.-dia. $\times 1\frac{1}{4}$ -in.-deep hole at the center point of each armrest mortise in the rear legs. By cutting these before the finished leg shape is cut, you avoid having to cut an angled mortise for the arm rest later. Cut the rear legs to shape using a band saw.

Clamp each leg between bench dogs and using a sharp chisel, finish removing the waste from each mortise. Corners must be square and sides smooth.

Next, cut the tenons on all rails, stretchers, seat supports and front legs

using a dado blade in your table saw. Clamp a stop block on the saw table as shown, so you can make accurate repeat cuts without measuring every piece. Since dado blades leave small ridges on the tenon cheeks, it's a good idea to saw the tenons slightly oversized and pare to fit with a chisel.

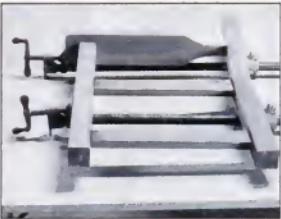
Trace the curved profile, shown on the drawing, onto the seat support rails and intermediate bench supports. Also transfer the outline of the arm rests onto the respective blanks. Use the band saw to cut all these pieces.

Next, dry-assemble the legs, stretchers and seat support for each bench and chair side with bar clamps. Check for fit and square. Then, while still clamped, scribe the position of the tenon at the

(Please turn to page 125)



Lay out 6° angle at back of arm rest, then clamp stock in vise or between bench dogs. Carefully cut tenon shoulders using a backsaw. Be sure to cut on waste side of line.



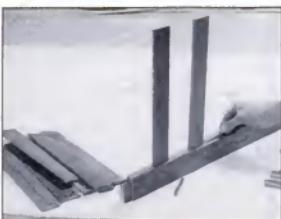
Join chair and bench side parts with epoxy glue and clamps. This glue does not require clamping for a proper bond, but clamps do keep parts in alignment while glue dries.



Cut $1/8 \times 7/8$ -in. groove in edges of all back rails to receive back slats. Use dado blade in table saw and clamp featherboard in place to prevent stock from kicking back.



Cut $1/8 \times 3/8$ -in. back slat spacers to length on table saw. Clamp stop block in place to ensure identical lengths for all similar parts and to speed repetitive cuts.



Begin assembly of chair or bench backs by alternately gluing slats and spacers into one rail. Then, lay assembly down on bench and glue opposite rail and spacers in place.



Join back assembly to side assemblies using epoxy glue and clamps. Be sure piece is square as clamped and that it rests on flat section of floor where legs will not rock.

MATERIALS LIST—GARDEN FURNITURE*

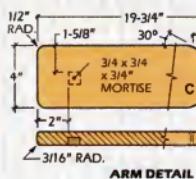
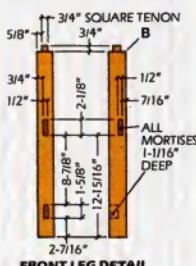
Key	No.	Size and description (use)	H	1	$7/8 \times 2\frac{1}{2} \times 55$ " teak (bench front rail)	P2	5	$3\frac{1}{2} \times 2\frac{1}{4} \times 25\frac{3}{4}$ " teak (chair seat slat)
A	4	$2 \times 4 \times 35$ " teak (chair/bench rear leg)	I	2	$7/8 \times 2\frac{1}{2} \times 55$ " teak (bench back rail)	Q	37	$1\frac{1}{4}$ " No. 8 fb screw covered with $1/2$ -dia. wood plug
B	4	$2 \times 2 \times 24\frac{1}{2}$ " teak (chair/bench front leg)	J1	1	$3/4 \times 2 \times 53$ " teak (bench front seat slat)	R	2	$7/8 \times 3\frac{1}{2} \times 48$ " teak (table top side rail)
C	4	$1\frac{1}{4} \times 4 \times 20\frac{3}{4}$ " teak (chair/bench arm)	J2	5	$3/4 \times 2\frac{1}{4} \times 56\frac{1}{2}$ " teak (bench seat slat)	S	2	$7/8 \times 3\frac{1}{2} \times 24\frac{1}{4}$ " teak (table top end rail)
D	4	$7/8 \times 2\frac{1}{2} \times 17$ " teak (chair/bench end seat rail)	K	1	$7/8 \times 2\frac{1}{2} \times 54\frac{1}{8}$ " teak (bench back seat slat)	T	9	$7/8 \times 2 \times 43\frac{1}{8}$ " teak (table top slat)
E	4	$7/8 \times 2 \times 17$ " teak (chair/bench stretcher)	L	2	$7/8 \times 2\frac{1}{2} \times 16$ " teak (bench seat center support)	U	4	$7/8 \times 1\frac{1}{2} \times 15\frac{1}{8}$ " teak (table leg)
F	14	$7/8 \times 2 \times 14\frac{1}{4}$ " teak (chair/bench back slat)	M	4	2" No. 8 fb brass screw	V	2	$7/8 \times 2\frac{1}{2} \times 44$ " teak (table side apron)
G1	22	$3/8 \times 3/8 \times 3$ " teak (bench back slat spacer)	N	1	$7/8 \times 2\frac{1}{2} \times 24$ " teak (chair front rail)	W	2	$7/8 \times 2\frac{1}{2} \times 24$ " teak (table end apron)
G2	6	$3/8 \times 3/8 \times 2\frac{3}{4}$ " teak (chair back slat spacer)	O	2	$7/8 \times 2\frac{1}{2} \times 24$ " teak (chair back rail)	X	8	Stanley No. 1912 table top fastener
G3	4	$3/8 \times 3/8 \times 3\frac{1}{8}$ " teak (chair back end slat spacer)	P1	1	$7/8 \times 2 \times 22$ " teak (chair front seat slat)	Y	16	$5\frac{1}{2}$ " No. 8 fb screw

*This materials list gives the parts required for making the bench, table and one of the two identical chairs.

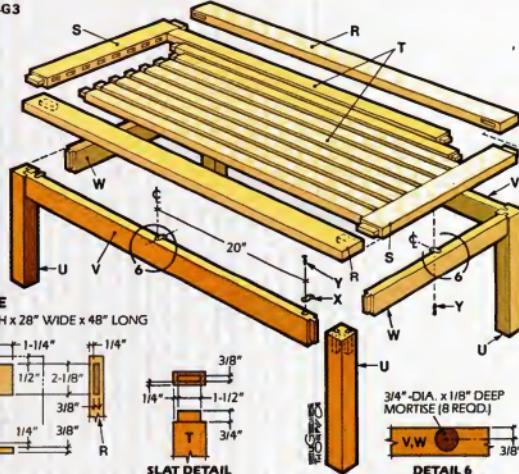
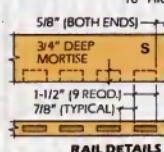
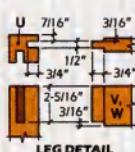
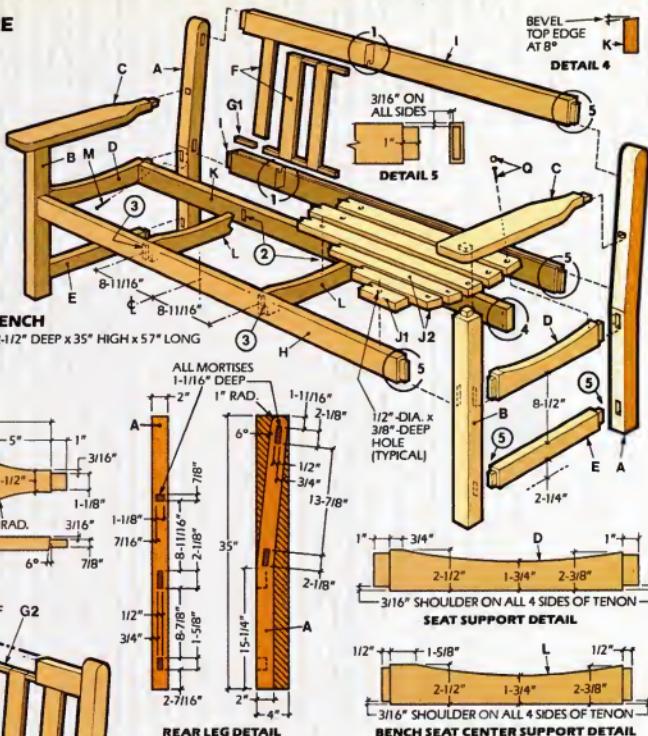
GARDEN FURNITURE

NOTES

1. 3/8" x 3/8" DEEP GROOVE
2. 1/2" x 1/2" DEEP x 2" MORTISE
3. 1/2" x 1/2" DEEP x 2-1/8" MORTISE



SLATS OVERHANG
1/4" ON ENDS
(CHAIR AND BENCH)



10

FURNITURE BUILDING: WAYS TO

PM's Master Craftsman shows different techniques for joining furniture legs to rails—an important step in nearly all furniture making.



Slip rails into open mortises cut in the leg. Rails fit together with edge-lap joints. Assemble the parts with glue only.

TEXT AND PHOTOS
BY ROSARIO CAPOTOSTO

Nearly all furniture—chairs, tables, desks, beds, benches—features some form of leg-to-rail construction. This basic design concept provides a practical method for joining furniture legs to create a sturdy structural support for a chair seat or tabletop. There is a wide variety of joints used to attach furniture legs to rails (often referred to as aprons). Shown here are 10 of the most commonly used and effective ones. The type of joint used for a particular project depends on several factors, including the strength requirement of the joint, leg shape, the appearance of the finished joint, type of woodworking tools available and the amount of time and effort you wish to spend.

As with all woodworking joints, cut leg-to-rail joints so the components fit together snugly. *Light tapping with a hammer should close the joint.*

To ensure accuracy, use table saw tenoning attachment to cut open mortise joints in legs.



JOIN LEGS TO RAILS

Open Mortise-And-Tenon Joint With Edge-Lap Rails

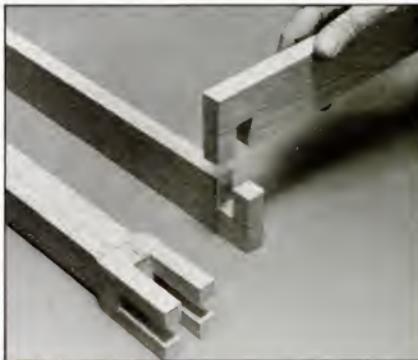
Finished leg-to-rail joints usually hide their construction method, leaving only a single glue line visible. But, as a design element, it's often desirable to make a joint that shows each component to reveal how the joint is constructed. One example of such an exposed joint is shown here.

Cut the open mortise-and-tenon joint with edge-lap rails on the table saw. Form stopped recesses on the leg sides using a jointer (see *PM's Guide To Using The Jointer*, page 100, Feb. '85).

First, mill the leg stock square. The leg shown measures $2\frac{1}{4} \times 2\frac{1}{4}$ in. Cut the rails from 4/4 stock (actual finished dimension: $1\frac{3}{16}$ in. thick). Next, cut the recesses on the sides of each leg using a jointer. Then, move to the table saw and cut the open mortises in the top end of each leg as shown in the color photo on the facing page.

Outline the mortise locations on each leg using a pencil. Note that the mortise depth must equal the rail width. Then, clamp the leg into the tenoning attachment and cut the mortises. Use a dado blade to cut the mortises if yours cuts deep enough to accept the rails. If not, use a regular saw blade and make repetitive cuts to form the mortise.

Next, notch the rails to make edge-lap joints. Cut the notches using a dado blade on the table or radial-arm saw. Be certain that the notch width equals the rail thickness and that the notch depth is exactly half of the rail width. For



Ready for assembly: An open mortise-and-tenon joint with edge-lap rails. Note how rails are cut only halfway through.

example, for a $1\frac{3}{16}$ -in.-thick \times 4-in.-wide rail, cut the edge-lap notch $1\frac{3}{16}$ in. wide \times 2 in. deep. The rail ends can extend from the legs slightly or be sanded flush, as desired. Apply glue sparingly to all parts and make sure you clamp the legs to the rails square.

Dowel-Reinforced Butt Joint

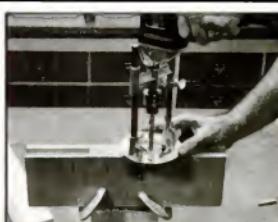
Easy-to-make dowel reinforced joints are commonly used in lightweight rail-to-leg construction. To provide greater strength and stability, always glue and screw corner blocks to the backside of the rails. Steel bracket corner supports, which are available at hardware stores, also could be used.

Start by boring dowel holes in the rail ends to accept $3/8$ -in.-dia. \times 2-in. hardwood dowel pins. Use a drill guide for perpendicular holes and uniform depth. Bore holes about $1/8$ in. deeper than half the dowel pin length, or $1\frac{1}{8}$ in.

Next, transfer the dowel hole locations to the legs using dowel centers, as shown. Then, bore the legs to accept the dowel pins. Be certain to use spiral-grooved or fluted dowel pins, not just sections of dowel.

Now apply glue sparingly to the walls of the rail holes and tap in the dowels using a soft-faced mallet. Also, spread a thin layer of glue on the rail ends and to the leg holes.

Tap the rails onto the legs and clamp the assembly square. Then, mount the corner blocks.



Bore dowel pin holes in the rail end using a drill guide. Clamp long boards to the rail to provide support for the guide's base.



Transfer the dowel hole locations in rail to the leg using dowel centers. Board clamped to leg keeps rail aligned properly.



Use the dowel center marks as guides to bore the leg dowel pin holes. Again, use the drill guide to ensure perpendicular holes.



First glue the dowel pins into the rails, then glue the rails to the legs. Glue corner blocks in place for additional strength.

Notched Rail Seat

This is one of the simplest, yet strongest, leg-to-rail joints you can make. The secret to the notched rail seat is that the leg really is made from three pieces—even though the finished leg will appear to have been milled from solid stock.

First, cut three identical boards for each leg. Next, glue two of the boards together using dowel pins, as shown, to keep the pieces aligned. Repeat this for each leg. Then, move to the table saw to notch the two-board assemblies. Make the first cut as deep as the rail is wide. It's necessary to cut two legs with the fence on the left side of the blade and two with the fence on the right side. This will ensure that when the third board is glued in place, all undercut saw kerfs will be hidden and the glue joints in each leg will all face in the same

direction and be least conspicuous.

Now use the miter gauge to crosscut each leg end, as shown, to form the right-angle notch that accommodates the rails. Finally, glue the third board to the leg using dowel pins for alignment.



Make the leg by first gluing two boards together. Insert $\frac{3}{8}$ -in.-dia. dowel pins to keep parts from shifting when clamped.

Next, join the rails into a frame using simple butt joints. Then, glue and screw the rails to the legs. Now you should set the assembly on a flat surface until the glue dries. You must be certain that the legs are square.



Execute a stopped cut to establish the depth of the notched rail seat. Keep a firm grip of the workpiece at all times.



After the stopped cuts have been made, crosscut the legs leaving a right-angle corner. Use the miter gauge to control the leg.



Now attach a third board to the leg using glue and dowel pins. This will form a notched seat for mounting the rails.



Glue and screw the rails together using simple butt joints. Then, attach the rails to the notched seat cut in the legs.

Dovetail Dado

Cut precise dovetail joints quickly and easily using a router fitted with a $\frac{1}{2}$ -in. dovetail bit. To ensure safe, accurate cuts, attach a simple jig to the router, as shown. The L-shaped jig screws easily to the underside of the router base.

Slotted holes permit adjusting the jig in and out without removing it. Since dovetails must be routed in a single pass, use a carbide steel-tipped bit. Advance the router into the work with slow, steady pressure.

First, adjust the jig to rout the dovetail dado (socket) in the legs. Clamp a stop block to the leg to control the length of the dado. The dado length equals rail width. Next, reposition the jig to rout the dovetail on the rail ends. Note that it's necessary to clamp scrap boards alongside the rail to provide a broader surface for the router to ride on. Also, tack-nail $\frac{1}{8}$ -in.-thick wood strips to the rail edges to prevent splintering the workpiece.

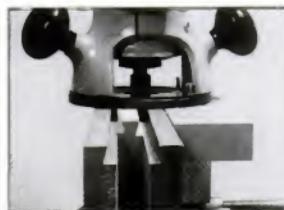
Finally, apply glue sparingly to all mating surfaces and tap the rails into the dadoes using a soft-faced mallet.



Guide the router with this homemade jig. Drill and tap holes in the router's base and attach the jig with two machine screws.



Rout dovetail dadoes in legs with slow, even pressure. Clamp a stop block to the leg (out of view) to control the dado length.



Pass router along both sides of the rail to form the long dovetail pin. Clamp two boards to the rail to support the router.



Completed dovetail dado joint shows interlocked components. Always make test cuts on scrap before routing workpieces.

Rail To Round Leg: Dowel-Reinforced Joint

Joining rails to round legs with dowel pins can be pretty tricky. The dowel pin holes must be perpendicular to the curved leg surface and the holes on one side of the leg must be perpendicular to the holes on the other side. The secret is to bore the dowel pin holes *before* turning the leg.

First, cut the legs and rails to size. Next, bore the dowel pin holes using a drill guide as shown for the dowel reinforced butt joint on page 115.

Then, contour the rail ends to match the round leg. Use a band saw to obtain the rough shape, then finish-shape the rail ends using a drum sander chucked in a drill press. Choose a drum sander that is equal in diameter to the desired leg diameter.

Now, turn the leg on a lathe. Be certain that the leg end with the dowel

holes is the same diameter as the drum sander to ensure a tight fit between the curved leg surface and the holes on one side of the leg must be perpendicular to the holes on the other side. The secret is to bore the dowel pin holes *before* turning the leg.

Apply glue to the walls of the holes in



First bore dowel pin holes in the legs and rails while the stock is square. Then, shape the pieces on a lathe and band saw.

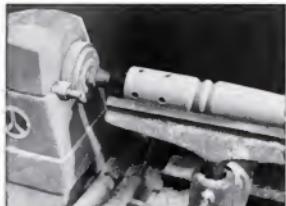
the rail and tap in the dowel pins using a soft-faced mallet. Then, spread glue on the rail end and in the leg dowel pin holes. Tap the rails onto the legs and clamp the parts square.



Contour the rail ends to match the round legs by first rough-cutting the rails on a band saw. Don't remove too much stock.



Use a sanding drum chucked in a drill press to smooth the rail ends. Be sure drum size matches the desired leg diameter.



Now turn legs on a lathe. Prebored holes save time, ensure accuracy. Turn leg end to match precisely the rail's contour.



First glue the dowel pins to the rails, then glue the rails to the leg. Note how rail end contour fits tight against leg.

Rail To Round Leg: Open Mortise Joint

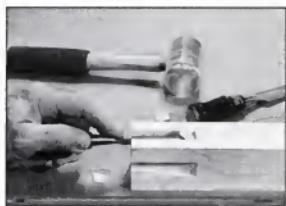
This joint isn't as difficult to make as the technique described above using dowel pins, but once again, the secret lies in preparing the stock before turning on a lathe.

Cut the legs and rails to size. Note that the rails are simply cut square and inserted into the mortises as snub tenons. Form the open mortises on the legs using a dado blade in a table saw. The width of the dado must equal the rail thickness and the dado length must equal the rail width. Clamp a stop block to the saw fence to ensure that the mortises are the same length. Then, square up the mortises using a sharp chisel.

Next, glue blocks into the mortises temporarily to permit turning the leg on a lathe. Apply just two small drops of glue for each block. After turning the leg, pry out the blocks and clean the mortises with a chisel.

Now, glue the rails into the mortises, setting them right by clamping the pieces square.

(Please turn to page 128)



Cut the open mortises in the square leg using a dado blade in a table saw. Square the mortises with a sharp chisel.



Glue filler blocks in the mortises temporarily to permit turning. Use only two small drops of glue to secure each block.



After turning the legs on a lathe, pry out the filler blocks with a chisel. Be sure to clean the mortises of any dried glue.

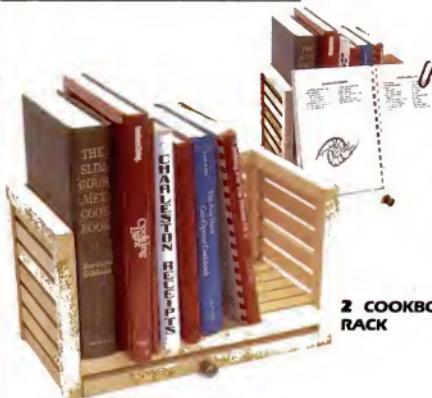


Rail ends are cut square to form snub tenons. Glue and clamp the rails to the legs. Check for squareness before the glue dries.

6 EASY-TO-BUILD KITCHEN COMPANIONS

Put together any one of these pine kitchen aids in a few hours—or build a matching set in a weekend.

BY GENE AND KATIE HAMILTON
AND STEVE WOLGEMUTH



2 COOKBOOK RACK

1 UTENSIL AND SPICE RACK



3 SERVING TRAY



4 FOLDING TABLE



5 POT RACK



6 MUG RACK



UTENSIL AND SPICE RACK

Any cook will appreciate this convenient rack that stores frequently used spices along with kitchen utensils. Made of lattice and $\frac{3}{4}$ -in.-thick pine stock, our handy countertop rack is an easy-to-build project.

Begin construction by ripping the corner posts and the front, back and sides of the top from the $\frac{3}{4}$ -in. stock. Rip all slats from $\frac{1}{4}$ -in.-thick lattice, or cut them from $\frac{3}{4}$ -in. pine stock.

Check the thickness of your slats, then cut grooves in the corner posts and the front and back pieces of the top assembly to receive the slats. The side pieces do not get a groove. Cut all the slat pieces to length. Sand all parts before beginning assembly.

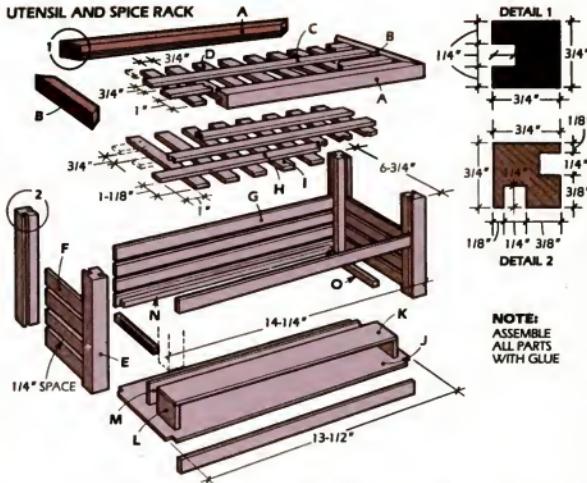
To help assure slat alignment, put masking tape alongside all grooves and mark the slat spacing on the tape. First, assemble the ends of the rack by gluing and clamping the side slats into the corner post grooves. Check alignment and allow the glue to dry.

Cut front, back and side top pieces to length and miter the ends. Assemble the top by gluing the short slats in the front piece first, then attach the back piece. Glue the two sides (Part B) to the front and back and clamp at the corners. Then complete assembly of the rack base by gluing the long front and back slats to the end assemblies. Clamp, check for square and let dry.

Cut the bottom and spice tray parts from $\frac{1}{4}$ -in. plywood. Assemble with glue and $\frac{1}{8}$ -in. brads. Glue the four bottom supports to the inside surface of the lower slats of the rack, positioned $\frac{1}{4}$ in. below the top edges. Cut corner notches in the bottom to clear corner posts. Slide the bottom and tray assembly into the rack and glue in place.

Install the lower grid parts with glue, checking to see that the alignment of the lower grid is the same as the top grid, so that utensils will stand upright. Glue and nail the top assembly to the corner posts using 4d finishing nails. Prebore pilot holes and set and fill the nail heads.

We finished the rack in natural color with several coats of oil finish. If you plan to stain the rack, do that before you install the top. Keep stain or finish away from the ends of the corner posts and lower corners of the top so glue will adhere, then touch up later.

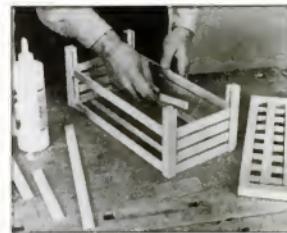


MATERIALS LIST—UTENSIL AND SPICE RACK

Key	No.	Size and description (use)	K	1	$\frac{1}{4} \times 3\frac{1}{4} \times 12\frac{1}{4}$ " plywood (spice tray top)
A	2	$\frac{3}{4} \times \frac{3}{4} \times 14\frac{1}{4}$ " pine (top front/back)	L	2	$\frac{1}{4} \times 2\frac{1}{4} \times 3\frac{1}{4}$ " plywood (spice tray side)
B	2	$\frac{3}{4} \times \frac{3}{4} \times 6\frac{1}{4}$ " pine (top side)	M	1	$\frac{1}{4} \times 2\frac{1}{4} \times 12\frac{1}{4}$ " plywood (spice tray back)
C	3	$\frac{1}{4} \times \frac{3}{4} \times 12\frac{1}{4}$ " pine (long top slat)	N	2	$\frac{1}{4} \times \frac{1}{4} \times 12\frac{1}{4}$ " pine (front/back bottom support)
D	8	$\frac{3}{4} \times \frac{3}{4} \times 5\frac{1}{4}$ " pine (short top slat)	O	2	$\frac{1}{4} \times \frac{1}{4} \times 5\frac{1}{4}$ " pine (bottom support)
E	4	$\frac{3}{4} \times \frac{3}{4} \times 5\frac{1}{4}$ " pine (corner post)			Misc.: Carpenter's glue, 120- and 220-grit sandpaper, $\frac{1}{8}$ " brads, 4d finishing nails, stain and/or oil finish.
F	8	$\frac{1}{4} \times \frac{3}{4} \times 5\frac{1}{4}$ " pine (side slat)			
G	6	$\frac{1}{4} \times \frac{3}{4} \times 13\frac{1}{4}$ " pine (front/back side)			
H	3	$\frac{1}{4} \times \frac{3}{4} \times 13\frac{1}{4}$ " pine (lower grid slat)			
I	8	$\frac{3}{4} \times \frac{3}{4} \times 6$ " pine (lower grid short slat)			
J	1	$\frac{1}{4} \times 6 \times 13\frac{1}{4}$ " pine (bottom)			



Mark corner posts and mitered top pieces to establish slat positions, then glue and clamp the assemblies, checking for square.



Glue and clamp supports for the bottom and spice tray assembly to inside of each bottom slat, $\frac{1}{4}$ in. below the upper edges.



Notch each corner of the plywood bottom to clear the corner posts, then glue bottom and tray assembly to the supports.



Glue lower grid in place, then glue and nail top to corner posts. If you plan to stain, apply before the top is mounted.

2



COOKBOOK RACK

Our cookbook holder, with its slide-out shelf, is a handy addition to any cook's kitchen. Begin by cutting corner posts, rails and shelf edge to the size in the materials list from $\frac{3}{4}$ -in. stock. Rip lattice thickness before cutting grooves, and adjust your cut for a snug fit. Cut a slightly oversized groove in the shelf guides. Miter the ends of the side rails and corner posts.

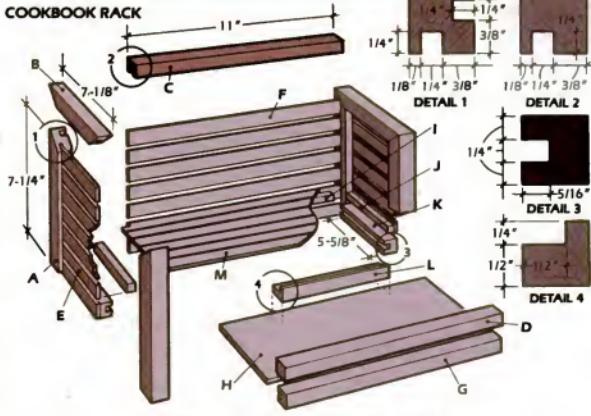
Check lattice thickness before cutting grooves, and adjust your cut for a snug fit. Cut a slightly oversized groove in the shelf guides. Miter the ends of the side rails and corner posts.

Assemble the ends first, using scraps as slat spacers. Glue the top slat into the grooves of the side top rails, then glue the rails to the side assemblies and clamp together.

Join the two ends by gluing the back rail and slats into one side, then add the other side. Install the front rail with glue and one 4d finishing nail at each end. Glue on the shelf guides and test the fit of the shelf.

Cut the bottom slat supports and glue and clamp in place. Then, cut the bottom slats, notching the corners of the rear slat to clear the corner posts. Glue and clamp in place. Center the shelf edge on the shelf plywood and glue in place. Now you should slide in the shelf, then glue the stop in position from below the shelf and secure with $\frac{1}{2}$ -in. No. 2 ft screws.

We finished our book rack with two coats of clear satin polyurethane, and mounted a small brass pull centered on the shelf edge.



Key	No.	Size and description (use)	I	1	$\frac{1}{2} \times \frac{1}{2} \times 10"$ pine (rear support)
A	4	$\frac{3}{4} \times \frac{3}{4} \times 7\frac{1}{4}$ " pine (corner post)	J	2	$\frac{1}{2} \times \frac{1}{2} \times 5\frac{1}{8}$ " pine (side support)
B	2	$\frac{3}{4} \times \frac{3}{4} \times 7\frac{1}{4}$ " pine (side top rail)	K	2	$\frac{3}{4} \times \frac{3}{4} \times 5\frac{1}{8}$ " pine (shelf guide)
C	2	$\frac{3}{4} \times \frac{3}{4} \times 11$ " pine (side bottom rail)	L	1	$\frac{3}{4} \times \frac{3}{4} \times 6\frac{1}{8}$ " pine (shelf stop)
D	1	$\frac{3}{4} \times \frac{3}{4} \times 6\frac{1}{8}$ " pine (front rail)	M	6	$\frac{1}{4} \times \frac{3}{4} \times 11\frac{1}{8}$ " pine (bottom slat)
E	14	$\frac{3}{4} \times \frac{3}{4} \times 6\frac{1}{8}$ " pine (side slat)			Misc.: Carpenter's glue, 120- and 220-grit sandpaper, 4d finishing nails, clear polyurethane varnish, $\frac{3}{4}$ " dia. brass pull, $\frac{1}{2}$ " No. 2 ft screws.
F	7	$\frac{3}{4} \times \frac{3}{4} \times 11\frac{1}{8}$ " pine (back slat)			
G	1	$\frac{3}{4} \times \frac{3}{4} \times 10\frac{1}{8}$ " pine (shelf edge)			
H	1	$\frac{1}{2} \times \frac{1}{2} \times 10\frac{1}{8}$ " plywood (shelf)			



Use scrap slat stock as spacers to align slats. Note that upper back and side slats are glued into the groove in back and side rails.



Glue floor supports in place, then notch the rear floor slat to fit around the corner posts. Glue remaining floor slats in place.

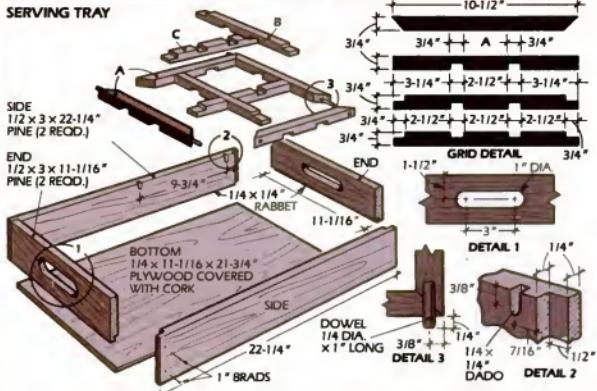
3



SERVING TRAY

Drinks and eats fit handily in this serving tray with its removable nine-compartment holder for glasses. Begin by cutting tray sides and ends from $\frac{1}{2}$ -in. thick pine stock. Rip grid pieces from $\frac{3}{4}$ -in. stock and cut to length.

Set up your saw with the dado head to make a $\frac{1}{4} \times \frac{1}{4}$ -in.-deep rabbet in the inside lower edge of the tray sides and ends for the bottom. Reset dado head to



a $\frac{1}{2}$ -in. width and cut rabbets in the ends of the sides for corner joints.

Use a router with a $\frac{1}{4}$ -in. straight bit to cut the stopped dados in the upper inside edge of the sides for the grid dowels, as shown in the drawing.

Lay out the position of the handle



Assemble the tray frame and cut plywood bottom to fit. Run a bead of glue in the rabbet, then attach bottom with 1-in. brads.

cutouts on the tray ends and bore 1-in. holes to form the ends of the cutouts. Remove the wood between the holes with a jigsaw. Wrap abrasive paper around a dowel to smooth the cutouts and round the edges.

Assemble the tray frame with glue



Glue middle half-lap joints together, then glue half-lap joints in outer frame to grid assembly. Clamp and let dry.

and 1-in. brads. Check the measurements of the bottom, cut it to fit, then glue and nail in place. Set the brad heads and fill the holes with wood filler. Sand with 120-grit abrasive paper, rounding all sharp edges slightly.

Cut the dados in the grid parts for their half-lap joints in groups. Set the dado head for a $\frac{1}{4}$ -in.-deep $\times \frac{3}{4}$ -in.-wide cut and test it on a piece of scrap. Clamp four grid parts together and cut the dados $3\frac{1}{4}$ in. from each end as shown. The inner grid parts have the same size rabbets cut at their ends.

Miter the ends of the outer grid parts to form the frame. Test the fit of the grid parts, then glue and clamp. When the glue has dried, sand the grid. Drill $\frac{1}{4}$ -in.-dia. holes in the sides to accept the support dowels. The dowels pass through the joint to strengthen it.

We applied polyurethane varnish and covered the tray bottom with a thin sheet of self-adhesive cork.



FOLDING TABLE

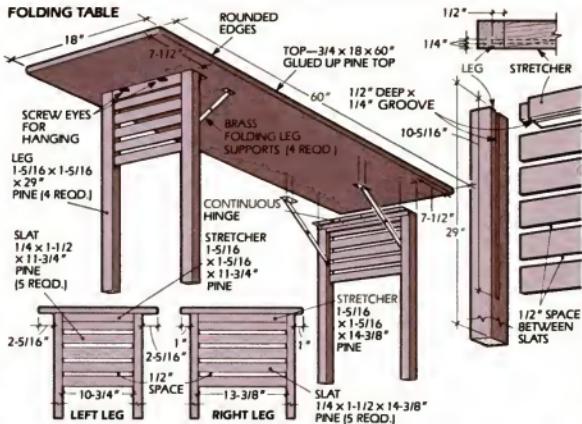
Our pine table is easy to stow away, yet unfolds to provide an ample 5-ft. work surface. If you wish, you can mount two screw eyes on its underside so it can hang from the back of a closet door. Purchase the pine-strip top ready-made or edge-glue and clamp up lengths of pine, then trim the top to size.

Cut the legs and stretchers from pine baluster stock and the slats from lattice. We specify a $\frac{1}{4}$ -in. groove, but check the thickness of the lattice and adjust this groove for a snug fit.

The length of the stretcher includes the $\frac{1}{2} \times \frac{1}{4}$ -in. tenon at both ends. The tenon is not in the center of the stretcher but offset $\frac{1}{4}$ in. from one side. Cut grooves in stretchers and legs to align with tenons. Use a chisel to square the end of the leg slot.

Assemble the legs by first gluing a slat into the groove in the stretcher. Then, using a piece of $\frac{1}{2}$ -in. scrap as a spacer, glue the other four slats into one leg. Next, glue on the other leg. Clamp the assembly until dry.

Radius the table edge with a router and $\frac{1}{4}$ -in. rounding-over bit. Cut hinges to size and install the legs and leg supports (Stanley No. CD 1956). Finish with two coats of clear polyurethane.



Glue top leg slat into stretcher, then glue this assembly to one leg. Glue and align the other four slats and clamp legs together.



Mount legs with continuous hinge and folding leg supports. Make sure supports do not bind with inner sides of legs.

5



POT RACK

Our pot and pan hanger offers convenient storage and adds a decorative touch to your kitchen. Begin by ripping the three vertical pieces to width, then cut them to length a little long so you can trim them after assembly. Cut the slats to length from lattice stock. Sand all the parts lightly and bore $\frac{1}{4}$ -in.-dia. mounting holes in both long supports.

Assemble the rack with $\frac{1}{8}$ -in. brads and glue, as shown in the photo. Begin with the top slat $1\frac{1}{4}$ in. from the top of the end supports and flush with the top of the middle support. Using a piece of $\frac{1}{8}$ -in. scrap as a spacer, mount the rest of the slats, keeping them square with the supports. Trim the supports flush with the bottom of the last slat. Set brad heads, fill and sand smooth with 220-grit paper. Finish the rack with several coats of polyurethane.

Pot hooks are formed from $\frac{1}{8}$ -in. brass rod, available at most hardware stores, bent into S-hooks. To hang the rack, screw into wall studs, or use plastic wall anchors.



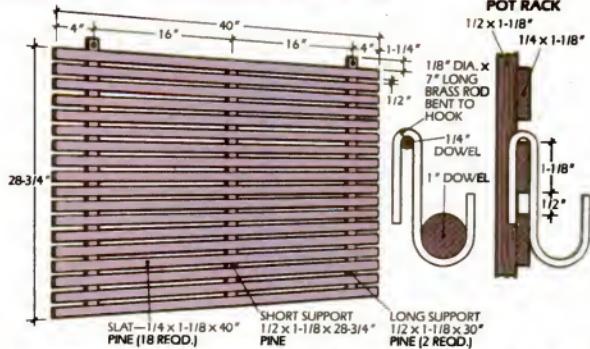
MUG RACK

This wall-mounted pine mug rack is an easy project for the first-time woodworker. The project requires minimal cutting and goes together quickly.

Cut the slats to length from pine lattice stock, and make the vertical supports using pine window trim parting stop, available at most lumberyards. Bore a $\frac{1}{4}$ -in.-dia. mounting hole in the tops of the outside support pieces. Sand the rack parts and mug pegs with 120-grit abrasive paper.

Place the supports on a flat surface. With glue and $\frac{1}{8}$ -in. brads, attach the top slat to back outside supports $1\frac{1}{4}$ in. from the top, and flush with the tops of all center supports. Make sure the slat is square to the supports before continuing. Use $\frac{1}{2}$ in.-thick scrap as a spacer and attach the rest of the slats. Make sure you don't nail where a mug peg will be located.

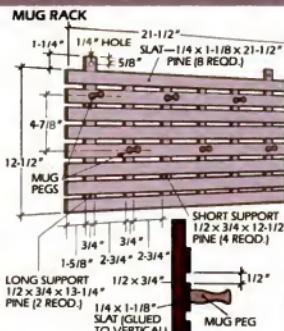
Mark the peg locations as shown in



Place $\frac{1}{2}$ -in. scrap between slats for even spacing, and secure slats with glue and $\frac{1}{8}$ -in. brads. Keep slats square with the supports.



Bend $\frac{1}{8}$ -in. brass rod around a 1-in. dowel to form the large curve, and around a $\frac{1}{4}$ -in. dowel to form the small curve on pot hook.



Use a piece of $\frac{1}{2}$ -in.-thick scrap as a spacer and attach slats with glue and $\frac{3}{16}$ -in. brads. Set brad heads, fill and sand smooth.



Bore snug-fitting $\frac{1}{2}$ -in.-dia. peg holes, as shown in the drawing, perpendicular to the rack surface. Glue and tap pegs in place.

9 mg. "tar", 0.7 mg. nicotine av. per cigarette, FTC Report FEB. '84.



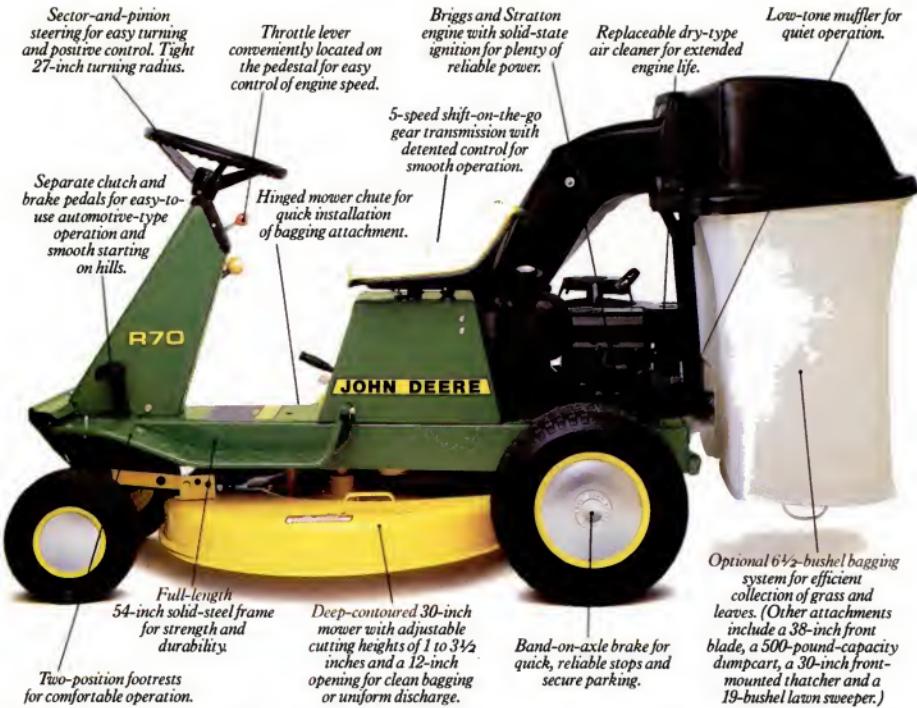
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ENGLISH GARDEN FURNITURE

(Continued from page 112)

back of the armrest, and the mortise on the bottom that receives the front leg. Cut the tenon with a backsaw, as shown, and the mortise like others explained earlier. Once again, it is better to cut both a little tight, then trim to a snug fit with a chisel. Use a router with a $\frac{3}{16}$ -in. rounding-over bit to ease the edges of the armrest pieces.

Assembly

We chose a specially formulated marine epoxy for gluing this furniture together. The West System Epoxy, made by Gougeon Bros., Box X908, Bay City, Mich. 48707, was developed for boat building and is not only extremely strong, but also is waterproof and does not require clamping or extremely warm temperatures to cure. Instructions for mixing come with the product.

Since teak is, by nature, an extremely oily wood, it is necessary to remove surface oil for good glue adhesion. Immediately before gluing any joint, wipe mating parts with acetone and let dry. Begin assembly by joining the legs, stretchers, support rails and arm rests. Apply epoxy and use bar clamps to draw the joints tight. Leave the clamps on to maintain alignment even though the glue does not require them. Check each assembly for square. Let all as-

semblies dry for at least 24 hours.

With a dado blade in a table saw, plough a $\frac{3}{8}$ x $\frac{3}{8}$ -in. groove in one edge of each back rail to receive the back slats. Then, cut the spacers between the slats to size.

Presand all the slats and rails with 120-, followed by 220-grit sandpaper. Then, run a thin line of glue in one rail groove. Begin with a spacer at one end and alternate slats and spacers until you reach the other end. Then, glue the opposite rail and spacers into place, and check for square. Next, join the intermediate bench seat supports to the front and rear seat rails.

After the side, back and bench seat assemblies have all properly cured, proceed with the final assembly. Apply glue to the joints and slide the back assembly and front rail into their respective mortises in the side assemblies. Position the other side over their matching tenons and bring the joints tight with clamps. Check for square. Note: On the bench you must add an additional seat support rail, (Part K). Attach this to the rear legs with two brass screws at each end.

Next, prepare the seat slats for installation. Prebore $\frac{1}{8}$ -in.-dia. screw pilot holes in the slats first, then bore a $\frac{1}{2}$ -in.-dia. x $\frac{3}{8}$ -in.-deep hole over each pilot hole. These will be plugged after the slats are in place. To make the plugs, use a $\frac{1}{2}$ -in.-dia. plug cutter in the

drill press. They should be cut at least $\frac{1}{8}$ in. long.

Bore matching pilot holes in the frame parts below, and attach the seat slats, as shown, beginning at the front of the chair or bench. Use $\frac{3}{4}$ -in.-thick wood scraps for alignment spacers. Glue the teak plugs in place so their grain runs parallel to that of the seat slats. After the glue has dried, cut off the plugs with a dovetail saw and pare flush with a sharp chisel.

Table construction

The techniques used in building the table are basically the same as those used for the bench and chairs. Cut the stock to size, then lay out and cut all mortises and tenons.

To assemble the table frame, begin by gluing the aprons to the legs. Then, glue the table top slats into one end rail. Glue the opposite end rail and side rails in place. Draw tight with bar clamps. Once both assemblies are cured, join with the tabletop fasteners as shown.

Because teak is an extremely oily and dense wood, it is noted for its remarkable resistance to rot. If you desire, the furniture can be left unfinished with no adverse effects and will, over time, weather to an attractive silver gray color. However, to best bring out the beauty of the wood and reveal the varied shades of grain, we applied two coats of Watco Teak oil. **PM**



Join seat slats to side supports and front rail with glue and screws. Bore pilot holes and countersink head $\frac{1}{8}$ in. deep. Use $\frac{1}{2}$ -in. spacers between slats for positioning.



Cut $\frac{1}{2}$ -in.-dia. wood plugs to cover seat slat screwheads. Glue plugs in place and once glue is dry, cut off waste with dovetail saw. Use chisel to pare plugs flush.



Cut all tenons on tabletop slats to size using dado blade in table saw. Then, cut tenon shoulders on band saw with stop block clamped in place to ensure identical cuts.



Begin assembly of tabletop by gluing top slats into one end rail. Then glue opposite end rail in place, followed by both side rails. Check assembly for square; let dry.



Mortise the tabletop fasteners into the top edges of the apron boards by boring $\frac{1}{4}$ -in.-dia. holes, $\frac{1}{8}$ in. deep. Screw each in place with a $\frac{1}{2}$ -in. No. 8 fl. screw.



Turn tabletop and base upside down and center base on top. Bore screw pilot holes into rails using fasteners as guides. Attach top by screwing fasteners in place.



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PMRV-4

Expires 12/31/85

THUNDER BOATS

(Continued from page 91)

that pass through a chamber tuned to make use of return pressure waves. These waves assist scavenging and increase the fuel charge volume.

You can't buy a Formula One engine at a dealership or even through Evinrude or Johnson. The sole agent in the United States for this exotic hardware is a company in Central Florida called Second Effort. They also are the only source of replacement parts.

You'll need more than the \$22,000 for the hardware. You'll also need certain qualifications. Before you can walk out with an engine, you'll have to prove your participation and experience in International Formula One racing.

The engine alone won't do you much good without a propeller. The props are made of stainless steel that is specially heat treated to get the molecules to interlock as tightly as possible. This process minimizes a prop blade shearing off at the hub. At 9,000+ rpm, the vibration is so violent that it can take the lower unit right off.

The boats used in Formula One racing are called tunnel boats because they actually ride on a cushion of air that is captured in a tunnel extending the full length of the hull. Walls of the tunnel are formed by two sponsons or pontoons, one on each side of the cockpit. The shape of the tunnel roof is critical in distribution of lift. The shape of the pontoons affects turning characteristics, drag and general stability.

The tunnel design has overcome one of the major barriers to 100-mpm-plus speeds in outboard racing—speed stifling drag of the lower drive unit through the water. This factor prevented boats with four 100-hp engines hung



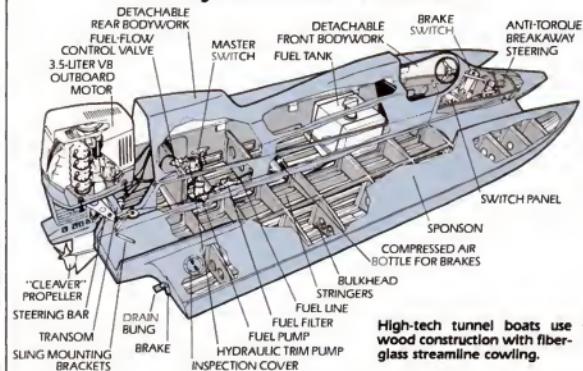
Formula One boats can whip around pylons at 90 mph with cornering forces up to 3g's—sometimes with upsetting results.

on the transom from achieving single-engine Formula One speeds—up to 150 mph in the straights. Tunnel boats lift up the lower drive unit so only half the lower unit is in the water. This gives minimum drag. The boats literally fly.

Tunnel-boat construction in this era of space age materials is of wood. Fiberglass can't stand up to the tremendous stresses imposed by racing (up to 100g's on the transom in a 90 mph turn). Wood gives the greatest strength for its weight in this application and it has the right amount of flex. Fiberglass is used for the streamlined cowling.

The boats weigh about 375 pounds and are 17- to 20-feet long. The price tag for one of these handbuilt beauties is \$16,000 to \$20,000, less engine.

Anatomy Of A Formula One Boat



High-tech tunnel boats use wood construction with fiberglass streamline cowling.

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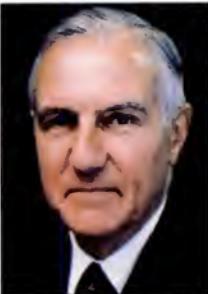
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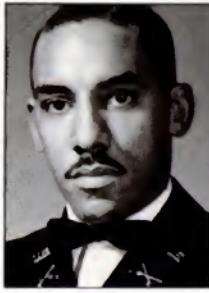
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Walter F. Williams, President & Chief
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Blind Mortise With Mitered Tenons

Blind mortise-and-tenon joints are often used when the rail connects near the center of a leg. Blind mortise joints are stronger and sturdier than open mortises because the tenon is fully enclosed and the rail has four shoulders bearing

against the leg, not just two.

First, form the blind mortises by boring a series of overlapping holes. Clean out the mortises with a sharp chisel. Next, move to the table saw to cut the tenons on the rail ends. Make the initial cuts to establish the four shoulders of each tenon.

Then, clamp the rail upright to the

miter gauge and trim the edge cheeks. Cut the wide face cheeks using a homemade table saw tenoning jig, as shown in the photograph.

Now, round the tenon corners with a chisel to fit the mortises. Finally, miter the tenons with the saw blade tilted 45°. Cut each tenon about $1/8$ in. short to create a glue pocket.



Form blind mortises by boring a series of overlapping holes. Brad-point bit keeps the bit from sliding into the adjacent hole.



Use the miter gauge to make the initial cuts to establish the four tenon shoulders. Note the stop block clamped to the saw fence.



Clamp the rail to the miter gauge to cut edge cheeks. Wood block in background is used to position the rail before clamping.



Cut face cheeks with homemade tenoning jig. Nail three boards together; middle board and fence must be same thickness.



Round the tenons with a sharp chisel to fit the blind mortises. A snug-fitting tenon is essential for a successful joint.



Blind mortise joint with mitered tenons is ready for assembly. Fully enclosed tenons create a strong, sturdy joint.

Bed Rail Fasteners

Here's a quick method for joining bed rails to bed posts using metal fasteners. The fasteners allow the bed to be knocked down, transported and reassembled easily. Fasteners are available at hardware stores and from mail order hardware companies.

Start by mortising the rail ends to accept the two-hook rail plates. Cut the mortises using a router fitted with a guide bushing and a $1/2$ -in. straight bit. Make a platform jig, as shown, to support the router and to provide a track for the bushing to ride in. Attach stop blocks to the jig to accurately control the mortise length.

Next, mortise the bed posts to accept the slotted post plates. Note that the post mortises are cut in two steps. First, rout the mortise that accommodates the plate. Then, make two smaller, deeper plunge cuts to accept the hooks of the rail posts. Be certain that all rail and post plates mount flush to their respective parts in order to create a tight, strong joint.



Mortise the rail ends with the aid of a platform jig. Space the plywood parts to accommodate the router's guide bushing.



Clamp the platform jig to the bed post for routing the plate mortise. Be certain that the plate mounts flush to the post surface.



Make two short, deep plunge cuts in the post mortises to accept the rail plate hooks. L-shaped guide on router controls cuts.



After routing the mortises, attach the fasteners to their respective parts. Completed bed rail is shown in the background.



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SMD Technology

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedented in radar detectors. In fact, PASSPORT is so new the magazine testers haven't even had a chance to select their superlatives.

Press Release

When the magazines do catch up, they'll report excellent performance. More than early warning, PASSPORT also provides a precise measure of radar range. Simply turn PASSPORT on and set the volume level. At radar contact, the alert lamp lights and the variable-pulse audio begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of

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GREAT MOVES

(Continued from page 103)

factories to be towed to their destination. The area was then drained and the buildings set and prepared for full operation within two weeks.

The trip from Japan to Brazil took three months. Each 30,000-metric-ton factory (both were about three city blocks long) was towed by a 20,000-hp Dutch supertug, with help from three standard seagoing tugs for each barge.

The concrete and steel construction had to set 15 feet above the water in calm seas. The factory barges had no rudders, so the tugs did the steering.

Around the corner

While the Jari pulp mill move ranks as the world's biggest long-distance haul on record, the transporting of the eight-story Indiana Bell headquarters one block in 1930 ranks as the grandaddy of America's major moves.

The phone company decided to erect a new headquarters in 1929. But, the existing eight-story building would also continue being used. It would be moved around the corner from its New York Street location in Indianapolis to the more prestigious Meridian Street. The 11,000-ton building was moved with such precision that it was occupied and

used during the 29-day operation.

Flexible gas, water and sewage lines were attached to the structure like umbilical chords. Electric and phone lines were given extra slack. A concrete slab was poured under the area to be traversed. Heavy timbers and railroad ties were laid in the concrete. After reinforcing the building supports, 4,000 steel rollers were placed under the steel I-beams attached to each column.

A steam engine using a pulley system supplied some of the power to pull the structure along the rollers. But, most came from 18 hand-operated jacks. On command, operators would pump six times in unison. Those six pumps would move the building about 3/8-inch. The building moved about 8 feet a day, as work crews moved ahead of support beams to place rollers in front of them.

The building was moved 52 feet, turned 90°, then moved another 100 feet to its new location. And it stood there for 33 years before it was torn down to make room for an expansion to the other headquarters building.

Moving the Shuttle

Patience is the key to moving any great object. Just as it takes 29 days to move a building around the block, it takes almost as many hours to move a giant Space Shuttle from its hangar to

the launching pad at Cape Kennedy.

A 122-foot-long Shuttle weighs about 165,000 pounds and has a wing-span of 78 feet. To take it on the 13-mile trip to the launch pad, NASA workers set the Shuttle atop a 130- by 114-foot transporter or crawler. The NASA crawler is powered by two diesel engines, each able to work up to 2,750 hp. The engines drive four 1,000-kilowatt generators that provide electric power to 16 traction motors. The entire crawler can be jacked up 6 feet.

When the Shuttle is loaded onto a crawler, the platform rises and men sitting in each of two steering cabs take control of the tracks on either side of the vehicle. It moves along at 1 mph on the way to the launch pad.

Modern block and tackle

It seems like a feat of modern engineering technology. But most of the systems involved in moving the Shuttle amount to pulleys, levers, inclined planes and ultra-modern block-and-tackle rigs.

Although the challenge is great, the machinery for great moves is hardly surprising. If there's anything new to be learned about moving great objects, it's probably buried somewhere in the Mexican jungle along with the vanished Olmec culture.

FM

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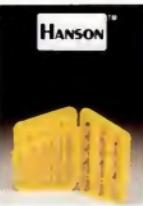
Check the Yellow Pages under Hardware for the Sentry store nearest you. Sentry Hardware Corporation, Cleveland, Ohio 44113. Merchandise shown in this advertisement is available from participating dealers only. Offer expires March 31, 1985. All Sentry dealers own their own stores. They select their merchandise and set their own prices. There may be variations in products, available quantities and prices in individual stores.



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Customers aren't even aware of it. Yet inventory statistics reveal a big decrease in shoplifting. In fact, in some cases by as much as 67 percent.

YOUR SUBCONSCIOUS IS YOUR ALLY, LET IT WORK MIRACLES FOR YOU AS IT IS FOR THOUSANDS TODAY.

Until recently, scientists were unable to harness the powers of the hidden mind. For years we knew it controls our destiny. But the question was: "How can we tap its strength?"

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NEW GEAR FOR FIREFIGHTERS

(Continued from page 134)

the firefighter in the middle is wearing an aluminized glass proximity suit that allows him to just about walk through flames. The men on either side of him are wearing approach suits, designed to let a firefighter stand for long periods in front of a blaze putting out 2,000° of radiant heat.

Radiant heat is like the energy produced by the Sun. If you can get out of its path, it won't affect you. The proximity suit in the middle is also designed to take 500° ambient heat. That's the heat carried in the air, the kind you can't duck away from. A good proximity suit also lets a firefighter touch extremely hot objects without getting scalded.

The silver on the suit, really an aluminized glass fiber, reflects 90 percent of radiant heat. And the gold/mylar visor reflects 100 percent of the radiant heat.

That takes care of the outside of the suit. The insides vary with the duty involved. Many high-tech firefighting suits are positive pressure. They use an air bottle to create slightly more pressure inside the suit than the outside air. This is the first step toward keeping hazardous chemicals away from a firefighter's body.

All Hazmat units, and some traditional firefighting battalions, are arming their people with three different suits, each made of a specialized material and each worn by itself or under an approach or proximity suit, with very different uses. Viton suits are highly resistant to a class of chemicals called PCBs. But they have no resistance to acetone and several other chemicals. Butyl suits, while they provide no protection against PCBs, do block out acetone and a range of substances irritating to the skin and lungs. Polyvinylchloride (PVC) suits protect the firefighter from a range of chemicals the other two types can't handle, but they can't be used in extremely high ambient heat.

Lifesaving tools

The special hazards of current-day fires have also brought special tools. One of the most important is the Hurst Model 32 Spreader. The giant spreader, also called the Jaws of Life, can exert up to 32,000 pounds of force to pry open stuck industrial doors or act as a huge monkey wrench capable of opening or closing stuck valves. Stuck valves led to explosions and deaths at a dozen oil refinery and chemical plant fires in the decade before the new tools.

While Hazmat is the newest way to fight specialized fires, several other techniques are rapidly changing the profession. The Los Angeles Fire Department is leading the way in the area of waterfront fires.

"We have 28 miles of waterfront," says Donald Manning, chief engineer with the L.A. Fire Department. "About 40 percent of the Los Angeles harbor is creosoted wood wharfing. Once those wharfs get going, it's almost impossible to stop."

Los Angeles firefighters hit the waterfront three ways to bring most dock fires under control within three hours. A fireboat hits the dock from the water, standard units hit it from the street and a special scuba diving unit attacks the blaze from under the dock.

The L.A. divers use a special hose dock. The dock is floated under a burning wharf and shoots a stream of water upward to put out flames at the heart of a fire fed by creosote. The dock, which was designed by members of the L.A. Fire Department, is made of very dense Styrofoam covered with glass cloth and resins.

"It combines the strongest part of the fireboat with the strongest ability of the divers," explains Chief Gene Schmitz, whose jurisdiction includes the harbor. The fireboat, he explains, can pump harbor water at a fast enough rate to put out any blaze. But it can't get in close enough to a smoke-enshrouded wharf fire.

The divers hook up a hose to the fireboat's output nozzle and run the line to the bottom of the Styrofoam dock. They connect it to a pipe that runs to the water surface and an upward-pointing nozzle that fires a stream of water straight up. A team of divers pulls the dock along the water from the fireboat to under the burning wharf, then water is streamed upward. This cuts down on smoke and breaks up the blaze.

Cameras cuts through smoke

Fires near water—on ships, oil platforms and waterfronts—are usually covered with very dense smoke. A British firm, English Electrical Visual (EEV), has come to the rescue with its new Thermal Imaging Camera.

The original camera, introduced in America in 1983, weighed just under 9 pounds. Its infrared sensors allow firemen to look through a viewfinder and see the source of the flames through smoke. If anyone is trapped in the fire, the rescuers can also see through the smoke to find him quickly. The camera leads firefighters to the source of a blaze to help them put it out faster.

The newest model EEV camera, introduced in America early this year, weighs under 5 pounds and has a handle for easier use. It also can be connected to a video cassette recorder so the blaze can be filmed in progress. That gives fire marshals a firsthand glimpse of the inside of the blaze in progress, something that is expected to lead to better arson investigations.

(Please turn to page 138)



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NEW GEAR FOR FIREFIGHTERS

(Continued from page 136)

About 90 percent of all the firefighters in America are volunteers. Can they stay abreast of the burgeoning technologies? "Yes. In fact, I think we're on the leading edge," says Chief Robert Lincoln of the Nassau County Fire Service Academy, where firefighters from suburban New York, Connecticut and New Jersey are trained.

Late last year, Lincoln's staff and members of the Alert Engine Co. No. 2 of Rockville Center, N.Y., tried on the latest proximity and approach suits just coming on the market. Lincoln says volunteers are eager to pick up new pieces of equipment and new firefighting techniques.

His words are echoed by L.A.'s Chief Schmitz. All 24 divers, and most other firefighters on his force, are also volunteers in their own communities. "Firefighting," he notes, "is a life work. We take home our work."

Future firefighting

The future of firefighting technology is practically at hand already. The major area still just barely explored is the skyscraper fire. Several pieces of equipment are just coming into use in an effort to revolutionize that firefighting arena. Three West German cities have installed a new "towering inferno" exit system on new office buildings. The system, made by the Wahlefeld Co., uses the motors and cables of automatic window-washing equipment to run a 2,200-pound rescue gondola from the roof to the ground in an office building fire (see *Safe Exit From A Towering Inferno*, page 156, Apr. '84). Several companies are working on super ladders to reach upper stories.

GCI Inc. of Canada, which makes industrial cranes, recently introduced a 140-foot tower ladder that carries a firefighting and rescue platform at the top. A pump relay system lets firefighters carry a hose to the top of the tower and shoot water at 1,000 gallons per minute. The ladder packs down to 65 feet for trips to and from its station. It is effective in open areas like office parks. A more compact version is in the planning stages.

Several chemical companies are working on fire retardants that can be sprayed on hot plastic to keep toxic fumes from spreading outward. And the software for Hazmat computers is constantly being upgraded.

"I couldn't say this 20 years ago," L.A.'s Schmitz notes, "but today, we're very confident that we can stop any fire that starts in this harbor before it can spread." Confidence. Along with Hazmat, you can put that word in the new firefighter's dictionary.

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HITCH-FREE HOOK-UPS *(Continued from page 62)*

quarters here, so get the smallest tip you can find for your soldering iron.

A second method uses individually inserted pins for D-type connectors, using either a friction fit for the wire or a barrel crimp. Connectors of this type come from AMP, which also markets a special crimping tool for \$40. Some careful use of less-costly long-nose pliers will do almost as well. With this type of connector, you buy an empty connector shell and loose pins. You create your own D-type connector by filling in just those holes that you need with crimp-type pins. AMP sells this as a complete kit with pins, one male and one female connector and a single shell. You might need two of these kits to make a cable.

PM's IBM connection

The last discrete method, and PM's favorite, uses another AMP connector with double V-shaped contacts for each wire. You also need a special tool—a "T-Handle" wire insertion tool (about \$4)—to press the wire firmly into those V slots (but used carefully, a small-bladed screwdriver will do the job just about as well). As with the vise-clamp technique, this connector requires no wire stripping; the pressure of insertion is all that is needed to shove the insulation back from the wire just where the contact is made. It's a really painless method of doing discrete wiring.

To make our IBM parallel connection, use a vise-type squeeze conductor for the male D-type that plugs into the computer. At the other end, you'll need one of the AMP T-Handle male Centronics connectors, since the cable set has some odd wiring changes. The wiring diagram in this article shows which wires go where.

Note that pins 1 through 14 run to the same pin numbers (not to the same pin locations) on both connectors. It's when you get to pin 15 that the wiring sequence begins to change to a more complicated procedure.

When buying these AMP connectors, check the V-notch size. There's a color-code dot in the middle of the connector's backside, which you may be able to see through the plastic polybag. You want yellow for working with 28-gauge ribbon cable. Other color codes are designed for larger wire diameters and just won't work at all with most sizes of ribbon cables.

Begin by peeling all 25 wires from each other for a space of about 2½ inches from the end that's going into the discrete connector. A piece of plastic tape around the ribbon 2½ inches from the end will keep the wires from peeling too far. Start each peel with a small nip from a pair of diagonal cutters. Pull each wire straight down (perpendicular to) the flat ribbon; do not pull wires apart sideways. This will give you good peeling action and keep each conductor's insulation intact.

Remember that when working with ribbon wires, the first one (red stripe) will be coming from pin 1 on the D-type connector; the next wire will be coming from pin 14, then pin 2, then pin 15, then pin 3 and so on. Although the discrete connector is designed for a round, plastic-jacketed multiwire cable, you can tape the ends of the individual ribbon wires you've pulled apart so they will fit nicely.

The following computer supply mail-order houses list do-it-yourself connectors and cabling. Write for a free catalog or phone in your order.

- BJW Sales Inc. 15 Stearns Rd., East Brunswick, N.J. 08816.
- Global Computer Supplies, 9138 Hemlock Dr. Hempstead, N.Y. 11550; 800-645-6393, in N.Y. 516-292-3400.
- Misco, One Misco Plaza, Holmdel, N.J. 07733; 800-631-2227, in N.J. 201-946-3500.

The first company, BJW Sales, provides a complete kit (\$25 postage) for making the IBM parallel connector cable diagrammed here.

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Model V8280A shown here. Other models look different but will have a similar metal knob.

be approximately $\frac{1}{2}$ " space between the bottom of the knob and the top of the control surface (figure A). That's the normal operating position. But if there is less space, the knob may be stuck down in the "on" position (Figure B). This damaged valve could allow raw gas to flow into your house. Explosion or fire could result.

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Model V5130 LP gas water heater control with plastic knob.

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9432 Challenger 75-83 inc Scamp

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8693 Holley 4150, 4160, 4170, 4180

9423 Stromberg Carburetors all thru 76

5341 SU Carburetors all models thru 76

1514 SU Carburetors all models thru 79

chrome, removed the climate-control system and deleted the electric rear-view mirrors and leather seats. The result is a \$19,000 "stripper."

On the other hand, the conventional Volvo chassis is superb. The turbocharged 2.3-liter Four towed the 740 to fourth at the dragstrip, just a tick behind the leaders, while the highly developed suspension breezed through the slalom faster than any of the others

in this group. The skidpad performance was right near the front as well, though the 740 did fall down in braking, slithering into eighth place. Despite its good performance at the track, the 740 Turbo feels old-fashioned. The four-speed shifter with its electrically engaged overdrive is no substitute for a good five-speed. To us, the door-stop styling of the new Volvo body is losing out to the aero look.

Saab Turbo

New this year is a double-overhead cam, four-valves-per-cylinder head to extract even more power from the venerable 2-liter turbocharged Four. In addition, Saab is offering an aero package for the three-door hatchback that adds plastic side moldings, an air dam and fancy three-spoke alloy wheels to the basic Turbo. The aero package also

(Please turn to page 146)

IMPORTED SPORTS SEDANS—SPECIFICATIONS AND DIMENSIONS

CAR	VEHICLE TYPE*	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEELBASE (in.)	LENGTH (in.)	WEIGHT (lbs.)
Audi 5000S Turbo	5-passenger, 4-door sedan	\$22,705	\$22,705	sohc 2.1 inline-5 turbo	5-speed automatic	105.8	188.7	2,700
BMW 325e	5-passenger, 2-door sedan	\$20,970	\$22,000	sohc 2.7 inline-6	5-speed manual	102.8	173.0	2,700
Mercedes-Benz 190E 2.3	5-passenger, 4-door sedan	\$23,160	\$24,445	sohc 2.3 inline-4	5-speed manual	104.9	175.0	2,700
Merkur XR4Ti	5-passenger, 3-door hatchback	\$18,503	\$18,412	sohc 2.3 inline-4 turbo	5-speed manual	102.7	178.4	2,900
Nissan Maxima	5-passenger, 4-door sedan	\$13,499	\$13,694	sohc 3.0V8	5-speed manual	100.4	181.7	3,060
Peugeot 505 Turbo	5-passenger, 4-door sedan	\$18,150	\$18,825	sohc 2.2 inline-4 turbo	5-speed manual	107.9	188.7	3,200
Saab Turbo	5-passenger, 3-door hatchback	\$18,150	\$21,395	dohc 2.0 inline-4 turbo	5-speed manual	99.4	187.8	2,800
Volvo 740 Turbo	5-passenger, 4-door sedan	\$19,045	\$20,140	sohc 2.3 inline-4 turbo	4-speed manual plus overdrive	109.1	188.0	3,000

*Audi 5000S Turbo, Nissan Maxima and Saab Turbo are front-engine, front-drive; all others are front-engine, rear-drive.

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Our \$21,000 test car had every possible option, but it was still outclassed by the similar but much less expensive Merkur XR4Ti. And the reasons are simple: a quirky interior in an old body, rubbery shifter and nose-heavy handling. It takes a lot of effort to drive Saab fast. It feels like the chassis has reached the limit of how much power can be pumped into it.

Peugeot 505 Turbo

Pininfarina bodywork is timeless and elegant, but the bolt-on rear spoiler is out of character. The interior is strange but pleasant, and the leather bucket seats are cozy. Dash layout is straightforward, but the ergonomics are atrocious. Unlabelled levers poke out at you from awkward angles, the steering wheel tips away like that of a bus, the doors are so heavy that it's like opening a safe from the inside and the shift lever feels like it has hinges in the middle.

But, the Peugeot is a surprisingly competent sports sedan. The smooth 2.2-liter Four turboed through the quarter-mile second fastest. The Peugeot was also right in the front rank in our handling and braking tests. For such an attractive and comfortable car, the performance is uncanny.

Audi 5000S Turbo

Our Audi test car was slow and flabby, with steering and handling described as "ponderous." At high speeds, there is a lot of pitch and yaw motion on rough roads, and there's considerable body lean in hard cornering. A good "all day on the turnpike" car, not a back-road tosser.

All in all, our group found the 5000S Turbo too big, too heavy, too numb—a sports sedan for old folks.

Mercedes-Benz 190E 2.3

There were two big surprises in this road test. One was the Merkur, a dark horse that came out of nowhere to win over our hearts. The other was the Mercedes. One tester wrote, "A real disappointment . . . always thought I'd buy a Mercedes if I won the lottery, but I just can't get excited about this car."

There's certainly nothing wrong with the 190E 2.3, but it's somehow, well, flat. At the track it was near the bottom in every test, despite the breathtaking \$23,160 price. As one tester put it: "This car would make a great Toyota."

Mercedes quality is a palpable thing. There was not a flaw anywhere, and the general level of fit and finish is superb, but we were surprised at some obvious design flaws. The center armrest, when down, gets in the way of the shift lever.

For this much money, you also deserve an adjustable steering wheel. The car feels secure and stable with controllable understeer, but the limits are not very high. It needs bigger tires and more horsepower to be a sports sedan.

Our test car came with the new ABS antiskid braking system, which—while it doesn't make the 190E 2.3 stop any faster—does prevent skidding.

In another year, Mercedes will answer all our complaints when they start importing the 190E 2.3-16. That's this same car with a 16-valve head, fatter tires, stiffer suspension and truly phenomenal performance.

Unfortunately, the 190E 2.3-16 will probably cost nearly \$30,000, so it will be even more expensive than any car in this class. Then again, it is a Mercedes.

Conclusion

The Merkur XR4Ti is far and away the best car in this group, judged as a sports car, a sedan or anything else. It's a great car at a reasonable price and we predict it will be a collector's item one day. If the Merkur is too swoopy for you—or if you need four doors—our next choice is the Maxima SE. Factor in price—the Maxima costs up to \$10,000 less than some of the competition—and there's simply no contest. It's one of the best buys on the market.

FM

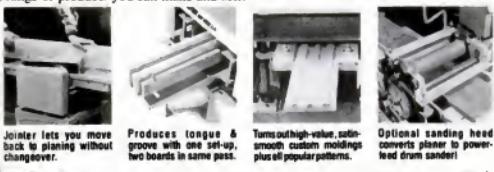
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Malcolm Bricklin's tiny International Automobile Importers no longer handles the Bertone (nee Fiat X1/9) and the Pininfarina (nee Fiat Spider). Current plans are to distribute the cars directly to the dealers, thus lopping \$2,000 to \$3,000 off the price and freeing IAI for its new project, the Yugo 55.

The Yugo 55 is a small econobox built around front-wheel-drive Fiat 128 mechanics by Zastava, in Yugoslavia. It was developed by Fiat and Pininfarina in 1975, has a 1.3-liter four-cylinder engine rated at 55 hp and will sell for less than the Chevrolet Sprint. That will make the Yugo 55 the least expensive new automobile you will be able to buy in America.

Jaguar

In another year, Jaguar will have a soft top Cabriolet version of the sporty XJ-S and a new sedan to replace the XJ6. Both will be powered by a new 3.6-liter dohc Six with four valves per cylinder. Later on, there will be an XKF sports car. All that is in the future, though. For 1985, there are no changes to the Jaguar lineup of XJ-S HE V-12, XJ6 and Vanden Plas. Since all three are at the top of their classes, there's really no rush to change.

Lamborghini

Lamborghini has held the price of the outlandish V12 Countach at \$99,500, and thrown in a set of Pirelli P7 Rally tires to boot. Not as refined as a Ferrari, the Countach is still the ultimate sports car statement. The V8 Jalpa will also be handled by Lambo's nine U.S. dealers.

Lotus

A new front suspension, new seats and new tape stripes are all that distinguish this year's Esprit Turbo from last year's. Either one will garner a Lamborghini's worth of excitement for half the price.

Maserati

Once famous as the only viable alternative to a two-seat Ferrari, Maserati now sells boxy sedans with Ferrari-like performance. The \$30,000 Maserati is the Biturbo, a tiny four-seater that looks something like a BMW 318i, but carries a 2.5-liter, dohc V6 under the hood, complete with two turbochargers. Coming next year are a four-door version, plus a convertible. The old-fashioned V8 Quattroporte is unchanged.

(Please turn to page 148)

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'85 IMPORTS: BUYER'S GUIDE

(Continued from page 147)

Mercedes-Benz

For 1986, Mercedes will replace the boxy 300D and 300TD with all-new aerodynamic models. They'll be offered with the tried-and-true 3-liter diesel—normally aspirated or turbocharged—plus a new 3-liter gasoline Six. Expect airbags and ABS brakes to be options. Next year we'll also see the fabulous 190E 2.3-16. In our European drive of this Mercedes factory hot rod, we found it to be a four-passenger, four-door, four-cylinder terror of the *Autobahn*.

This year, the big news at the house of the three-pointed star is the addition of standard-equipment ABS anti-lock brakes on the 300SD, 380SE, 380SL, 500SEL and 500SEC. ABS is optional on the little 190, which also boasts an extra 7 hp. Myriad detail changes range from heated rear-view mirrors to lower differential ratios on some models.

Merkur

The Merkur is a whole new line of captive imports built by Ford of Europe and brought in from West Germany by Lincoln-Mercury. This year we get the sporty XR4Ti, a three-door hatchback with turbocharged 2.3-liter Four. Ford took great pains to bring the Merkur to America as an undiluted performance sedan. Stateside buyers get a 175-hp engine that actually betters the Euroversion's V6, a real switch in the way imports usually get Americanized.

In another year, there will be a similar four-door sedan and five-door station wagon. Lincoln-Mercury hopes to import more than 100,000 Merkurs next year, which ought to be a cinch. The car is tough, beautiful, fast and fairly priced.

Peugeot

The new top-line at Peugeot is the 505 Turbo, which has an all-new, overhead-cam, turbocharged Four with five-speed. You'll know it by the spoiler on the trunk lid, alloy wheels and upscale tires. The regular 505 series is the same as last year, with your choice of sedans and wagons with diesel or gasoline power. The plush 604 V6 is history.

Porsche

Porsche is on a power binge. The big 928S now has four valves per cylinder for the V8, good for an additional 50 hp and performance on a par with the equally power-happy Corvette. The popular 944 will finally get its turbocharger, which should make one of the nicest all-around sports cars on the market even nicer. The venerable rear-engine 911 Carrera models remain exactly the same.

(Please turn to page 150)

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DUMBO*	5251052
THE WAY WE WERE*	1523002
ON GOLDEN PONO	0523082
THE BIG CHILL*	0527022
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STRIPES*	1513082
ROMANCING THE STONE*	0894092
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'85 IMPORTS: BUYER'S GUIDE

(Continued from page 148)

Renault

The only French-built Renaults sold in this country are the Sportwagon (nee Renault 18i wagon) and the Fuego coupe. Both cars now have 14-in. wheels and a larger 2.2-liter normally aspirated engine. Next year, a restyled version of the V6 Alpine A-310 will be offered on AMC dealers' lots, along with the big Renault 25 luxury car and the Espace minivan.

Rolls-Royce

Only minor trim changes distinguish the Silver Spirit and Silver Spur sedans, the Camargue coupe and the Corniche convertible from last year's models. And of course, that's the idea—Rolls is a Rolls is a Rolls. The Bentley name is being revitalized with a new sportier version called the Continental. Sporty compared to a Rolls-Royce, not a Lotus.

Saab

Every Saab Turbo now has an intercooler, four valves per cylinder and 160 hp; 900 and 900S models soldier along with only two valves. The fabulous European Turbo 16 aero package—which features plastic side skirts, high-speed Pirelli P6 tires on three-spoke wheels and antisway bars—will be the Swedes' sportiest offering. This fall we'll see the all-new 9000 Turbo—a five-door hatchback to compete with Audi, Mercedes and BMW—as well as a convertible version of the 900 Turbo.

Volkswagen

VW has completely redone its line for 1985. The Golf replaces the Rabbit. It's softer-edged and more rounded, and so is the Jetta, which is based on the Golf. Both are available with a performance package (GTI on the Golf and GLI on the Jetta) that adds horsepower, handling aids and just enough cosmetic changes to make the car work. The fun-loving Cabriolet continues to be based on the Rabbit body.

The Scirocco, Vanagon and Quantum basically are unchanged, though the Quantum now is available with a four-cylinder engine as well as the new 2.2-liter Audi five-cylinder.

Volvo

All Volvos are now four-door sedans or wagons; the two-door coupes have been dropped for lack of interest. There's a new 2.3-liter engine with or without the turbo that's also used in the big 760 GLE. A sporty version of the 760 with black-out trim and less expensive appointments is called 740 Turbo. At \$19,000, it's high-excitement transportation despite the conservative exterior treatment.

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Droop snoot helps the Ford's looks and aerodynamics, but puts a minor cramp in underhood service.

PM DRIVES FORD'S AEROSTAR MINIVAN

When it goes on sale in May, Ford's minivan will be a real head-turner.

BY DANIEL CHARLES ROSS
Detroit Editor

The front-engine, rear-drive Aerostar is a minivan that Ford is making in three versions. The Aerostar that'll be sold over the counter is the "wagon." It has side glass and is decked out with an abundance of car-like options. The "van" is a slab-sided, windowless model that'll make a great tradesman's vehicle. The RV Conversion Van is only available to conversion outfits or dealers who will customize it prior to sale. (Good thing it's not sold directly to the public; it brings new meaning to the word *stripper*. It has no headliner, no interior appointments, not even seats. Ford developed the van in concert with van converters to be completely ready for customizing when it hits the shop door.)

There's a lot of difference between the van and wagon, as we found out driving the two. Without the weight carried by the more luxurious wagon,

the van is light and much more nimble to drive. The wagon is more ponderous over bumps, in steering and in handling. Both models have variable-ratio rack and pinion steering but, at 37.5-ft. curb to curb, the van has a turning circle 2.3 ft. tighter than the wagon. I could have more fun with the van, I think, because it offers greater opportunity for personal expression in customizing.

Ford thinks the windowed wagon version with standard five-seat capacity will be important to the female buying

influence. The vehicle's step-in height is only 14 in., about the same as the LTD. Other Aerostar dimensions are similarly car-like—an overall length of 174.9 in. astride a 118.9-in. wheelbase, overall height of 72.1 in., front head room of 39.6 in. and a maximum front-seat leg room of 40.9 in.

The Aerostar wagon in XLT trim leaves little to be desired. All the up-level appearance and interior goodies are included, such as a digital electronic

(Please turn to page 154)



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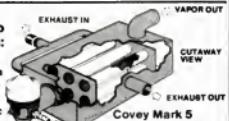


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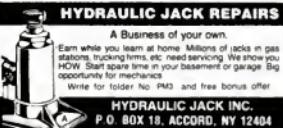
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FORD'S AEROSTAR MINIVAN

(Continued from page 152)

instrument cluster, premium seating, air-seat air conditioning and heater, plus extra lockable storage compartments. On the road the little wagon travels smoothly.

But this is no sport truck: It's built to carry up to seven passengers in an optional two-two-three seating configuration in style and comfort. In this form, the two rear seats each unfold to form a flat upholstered surface for sleeping. Rear-seat passengers (the kids) can even have their own separate radio tuner and volume controls to hear through headsets, keeping The Clash out of the Mozart.

Computer-aided design

Computer simulations helped Ford engineers design the Aerostar suspension, resulting in coil springs at all four corners supplemented by twin-tube, low-pressure, gas-charged shock absorbers. Unsprung weight is kept down through the use of lightweight aluminum driveline components.

Power train choices consist of the standard 2.3-liter inline Four or the optional 2.8-liter V6, coupled to either a standard five-speed manual transmission or optional four-speed automatic with overdrive and electronically controlled torque converter.

Brakes are front discs and rear drums with power assist. Tires range from P185R14 to the fatter P205S in up-option or heavy-duty packages. Brake pedal pressure was average for a van, and the brakes responded well to the range of conditions encountered during our brief drive.

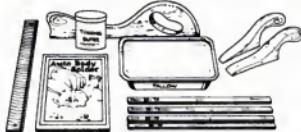
The new AL4D automatic overdrive transmission features a helpful downshift procedure for more comfort in operation. In situations where a torque converter automatic overdrive might normally downshift to negotiate, say, a slight incline, the Ford tranny simply disengages the lockup torque converter clutch. Ford sources claim this provides a small but effective multiplication in torque to improve transmission output. The result, according to Ford, is tantamount to a gentle downshift without the annoying hunting that you get between direct-drive third gear and overdrive fourth on many of today's "tuned-for-economy" automatics.

In the windowless van model, the right-side sliding door opens and closes easily, giving good access to the cargo bay. Width of the flat-load cargo floor is 64.5 in., with 48.4 in. between wheel houses. Cargo floor length is 86 in., so you'll have to leave the back door open to carry 4 x 8-ft. panels, but at least you can lay them flat between the wheel

(Please turn to page 165)

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Featured in Oct. '83
Hot Rod

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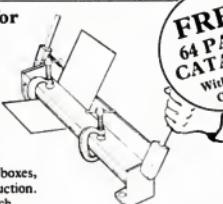
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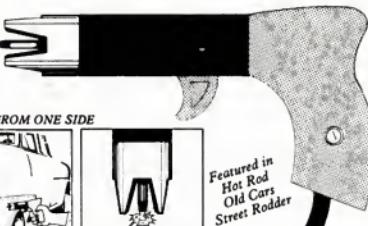
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It welds any steel between 18-26 gauge. (Auto body steel metal is between 18 and 22 gauge). Ideal for welding replacement panels, floors, brackets, clips, braces, channels, etc. Welds from one side so it can even do blind panels that ordinarily can't be spot welded. Comes with two pressure heads — four prong for control on flat areas and two prong for reaching into edge and recess work. Proper replacement electrodes available through Eastwood. Gun comes complete with connection wire, spare electrode, 2 pressure heads and complete instructions.

#4353 Spot Weld Gun \$35.95
 #4321 Package of 10 extra electrodes \$9.75
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TELEVISION

THE NEW ANTIQUE

Your old TV might be more than high-tech junk; some sets have become valuable collectibles.

BY MARY CELESTE UMANS

If you're bored with the prospect of spring cleaning, try turning this season's ritual cleansing into a treasure hunt. That old television set collecting dust and occupying space in the basement or attic might be worth a fortune.

The latest trend in the world of collectibles is television, and it could give the phrase "Golden Age of Television" new meaning that the fans of Uncle Miltie, Howdy Doody and The Honeymooners never imagined.

To a collector, your old TV set could be worth \$50, maybe even thousands of dollars. But even if you never plan to part with the set, you might enjoy knowing that the old electronic babysitter has more than sentimental value, and derive great personal satisfaction from restoring it to its original condition.

As antiques go, TV's a youngster: It's hardly 50 years since the first commercial sets were shown at the 1939 World's Fair.

"Until recently, television sets weren't old enough to seriously consider collectible," says Bruce Mager, proprietor of WAVES in New York City—one of the few retail outlets for early TVs and boob-tube memorabilia.

Mager and other collectors tell PM that age isn't the only factor that makes a TV set valuable. Other considerations include mechanical and cosmetic condition, distinctive features or styling, and brand name.

As far as age goes, the very earliest TVs had a mechanical operating system based on the scanning disc invented by Germany's Paul Nipkow in 1884. These sets were used primarily for experimentation, and they're easy to identify by the rotating disc with spiral-pattern perforations. If you have one, you've got a valuable antique.

Inventions such as the iconoscope (electronic camera eye) and kinescope (receiver picture tube) led to the elec-

tronic TV system commercially launched in 1939. These sets were slow to catch on: They cost almost as much as a new car, and broadcast programming was minimal. If your set tunes only four or five channels, it's probably pre-World War II. These sets are rare and usually found around New York and Los Angeles, where the early TV stations were located.

Post-war sets built from 1946 through the late '50s coincided with the Golden Age of Television when programs were broadcast live—not taped. These sets have value too, but how much they are actually worth depends on a number of factors.

Condition and features

In general, the better its condition, the more a set is worth. A working set might have twice the value of one that's not (the exceptions are the pre-war models, which are valuable on their own). Knobs are usually the first

(Please turn to page 158)



Philco's 1957-58 Predicta (above) is unique for its rotating, swiveling screen.



Vintage 1953-54 Dumont, left, is prized for its cabinetry and defunct brand name. Three-inch screen and compact size give value to the 1949 Pilot portable (above).



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As part of a nationwide publicity campaign, the National Historic Mint will give away 1,000,000 (one million!) of its Official Statue of Liberty Diamond Belt Buckles for the astonishing price of only \$5 each to the first one million persons who return this original printed ad to the Mint's New York Headquarters (below) before Midnight, May 31, 1985.

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This is the same Official Statue of Liberty Diamond Belt Buckle nationally advertised in leading media and publicized by the Mint throughout America. A proud symbol of our nation's ideal of freedom, each buckle is layered in *both* genuine sterling silver and genuine 14 karat gold.

And in addition—directly at the center of Miss Liberty's famed Torch of Freedom—there sparkles the breathtaking beauty of a genuine 17-facet solitaire diamond.

Issued only in this special Limited Edition, the dies for this buckle will be immediately destroyed after final distribution, thus assuring permanent rarity for collectors.

These Statue of Liberty Diamond Belt Buckles will not be sold by the Mint at this price in any store. To obtain one at this special direct-from-the-Mint price, mail this original printed ad before Midnight, May 31, 1985.

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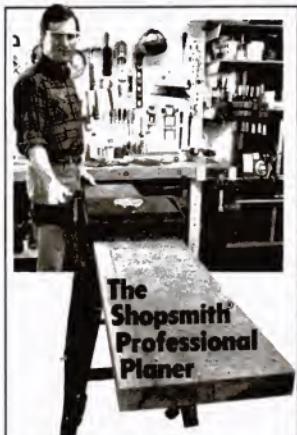
Should you ever wish to sell or redeem your historic Statue of Liberty Diamond Belt Buckle, the National Historic Mint pledges to repurchase it from you upon demand, any time within the next fifty (50) years, for the full cash price you paid.

There is a limit of two (2) Statue of Liberty Diamond Belt Buckles per address at this special price, but if your request is mailed early enough (before May 25) you may order up to seven.

To obtain your historic Statue of Liberty Diamond Belt Buckle, mail this original printed ad together with your name and address and \$5 for each buckle. Add only \$2 shipping and handling no matter how many buckles you are requesting. (New York residents add sales tax.) Allow up to 6-8 weeks for shipment. Mail to: National Historic Mint, Statue of Liberty Belt Buckle Offer, Dept. 114-19, Box 1733, Hicksville, New York 11802. (E25420)

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TELEVISION: THE NEW ANTIQUE

(Continued from page 156)

things to disappear. On pre-war sets, most were unique to the model. On post-war receivers, they were often interchangeable, so they're fairly easy to find. But be careful: If a set has no knobs, the insides may be gutted, too. If the internal parts are intact, replacing a few tubes or components might get the set up and running like new.

Uniqueness is another element in the antiques business. Every collector looks forward to that special set with unusual features or styling. Zenith and Tele-Tone once upon a time offered "port-hole" TVs with round picture tubes. The compact, trapezoid-shaped Sentinel is another model appreciated for its distinctive appearance.

Sometimes, personal taste dictates uniqueness. Many collectors prefer sets without cabinet doors. These sets are easier to identify and admire. The circa 1949 Pilot, smallest of the old TVs, is desirable not only for its 3-inch screen, but for its ease in display and storage.

Styling and brand

A lovely cabinet can be important. The '50s oriental designs, for instance, are very hard to find. People consider them pretty pieces of furniture. And those who have them don't want to give them up.

On the other hand, the Philco "Predicta" has a rather ugly housing of dubious quality. But people love to collect these odd models just because they look so strange.

The make of a television doesn't necessarily dictate its value, but some manufacturers' products are more in demand than others. Dumont, a now-defunct brand that attended the birth of television, is especially popular right now. Chances are good that any of the lesser-known brand names, such as Andrea or Emerson, will also be highly marketable.

New TVs from old

It's time to clean up your potential gold mine to see exactly what you have and what needs to be done. For the initial cleaning, use only mild soap and water. Modern cleaners may hurt the old finish, dissolve putty knobs or fog plastic windows.

If the finish is damaged, you may want to have it restored, or do it yourself. This could take anything from oil rubs to hard varnish. There are also good corrective chemicals available at antique and hardware stores.

Anytime non-original parts are used to update a set, it decreases its value as a collectible. Picture tubes are still available for many of the post-war models. Transformers, tuners and other parts

that are a little more unique to a set can sometimes be found in the junked chassis of similar models. You also might find universal parts to fit into the shell of the old TV without destroying the authentic appearance of the piece. Surplus Electronics, a chain with stores in many cities, is one source for replacement parts.

If you're hoping to sell an old set, or if you're thinking of becoming a collector, several avenues are open to you.

The collectors' network

Dan Gustafson, a major TV collector who owns 15 pre-war and 50 post-war sets, says that one of the best ways to network with other collectors is through local radio clubs.

"As interest in the field grows, you're finding more and more TV people among the radio collectors," observes Gustafson.

"Classified ads in club newsletters reflect this with more frequent requests or offers for TV and related items," he adds. "It's a logical extension from radio to TV since these mediums have so many roots in common."

Many major cities have local radio clubs. Most are chapters of two national groups: The Antique Wireless Assn. Inc., (Holcomb, N.Y. 14469) and the Antique Radio Club of America, (c/o The Antique Radio Gazette, Jack Davis, Antigue Television Editor, 63 Midchester Ave., White Plains, N.Y. 10606). Either of these organizations should be able to provide extensive information on local activities.

Since Bruce Mager at WAVES is in the business of buying and selling, he's a good source for estimating value and possibly finding a buyer for your set. Dan Gustafson also is willing to correspond with anyone seeking information on collectibles.

In both cases, include a picture of your set with the make and model number. Mager can be contacted at WAVES, 32 East 13th St., New York, N.Y. 10003. Write Dan Gustafson at 233 East Ontario, Chicago, Ill. 60611.

If you think your television set is unique and you're willing to part with it, you might want to participate in the archival activities at the University of California, Los Angeles.

In addition to its work in preserving old films and programming, UCLA has begun a collection of hardware. To inquire about donating your set, send a picture with make and model to the UCLA Foundation, College of Fine Arts, A-265 Murphy Hall, Los Angeles, Calif. 90049. That old TV might return many times its original value in the form of a tax deduction!

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Item #	Qty.	Cap.	Sale	Tire Only
1211	480 lbs	4	\$24.00	\$15.50
1212	570 lbs	4	\$33.00	\$22.00
1216	480x12	4	\$36.00	\$22.00

Trailer Springs, 1/2" wide-wire coil 1000 lb. capacity.

Capacity Springs, Leaf

Item #	Capacity	Leafs	Sale
1250	4500 lb	2	\$22.00
1251	2000 lbs	2	\$24.00
1252	3000 lbs	2	\$27.00
1253	4500 lb	2	\$29.00

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Capacity Springs, Leaf

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PM OWNERS REPORT: MERCEDES 190



Even prestige car buyers can appreciate the good fuel economy.

When we asked Mercedes owners specifically what made them choose the 190, one simple, direct answer came back: "Because it's very much a Mercedes."

That quote from a California dentist sums up the feeling of most owners we surveyed. Nor was our dentist alone when he went on to say, "The quality and design, while not so elaborate as the more expensive models, is what I expected from Mercedes."

What do owners expect from this new baby Benz? It's smaller, lighter and more fuel efficient than any of its brothers, yet it's by no means inexpensive. In purpose, it gives Mercedes an entry-level sedan: Half of all first-time M-B buyers do choose the 190. The 190 also

"If my husband could go to the showroom today and drive one away, we would own two."

—FLORIDA CONSULTANT

"This car has a star on the hood, but it is not a Mercedes."

—MASSACHUSETTS MANAGER

"I can best describe the car as a grand touring automobile."

—OHIO INSURANCE EXECUTIVE

"The shifting of the automatic transmission is rough."

—ILLINOIS COMPANY PRESIDENT

gives the company a boost in Corporate Average Fuel Economy (CAFE).

Mercedes 190 owners definitely appreciate the fuel mileage they're getting, both from the 2.3-liter gasoline engine and particularly from the 2.2 diesel. Economy turned out to be the



The interior of the "baby" Mercedes is much like its bigger siblings: traditional, conservative, comfortable and luxurious.

A NATIONWIDE SURVEY BASED ON 1,364,046 OWNER-DRIVEN MILES

190's second-best-liked feature, right behind handling. According to the owners we interviewed, the gasoline-powered 190E delivered 23.1/28.5 mpg (city/highway); that's better than the

(Please turn to page 162)

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joint tools for connecting and replacing tubing...and one of the most important pieces of equipment you can have, a top-quality vacuum pump for evacuating air and contaminants. It's a professional's "must," saving time, trouble, and callbacks.

You also get NRI's exclusive demonstration units...special kits that teach you the principles of electrical circuitry, controls and temperature sensing units, tubing fabrication, and joint making. These units give you the "hands-on" experience you need to reinforce your theory lessons. And NRI's "bite-size" lessons are specially

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513-035

MERCEDES 190

(Continued from page 160)

EPA city figure of 19.0 and the 20.3 mpg in our sports sedan test (see page 92). The diesel 190D managed a no-fooling 33.9/40.6 mpg.

About a third of our interviewees

were diesel owners. A few diesel owners complained mildly about the lack of power, but most were aware of this from the outset. The 190D retails for only \$80 more than the 190E and gets about 50 percent better mileage.

Nearly 61 percent of our respondents listed handling as the car's best attri-

bute. "Instant response," as a Florida distributor put it.

A West Virginia physician told us, "While the 190 rides superbly on the interstates, the intriguing thing about it is that on twisty mountain roads it seems to handle better the harder it's pushed. It's as if the car had been

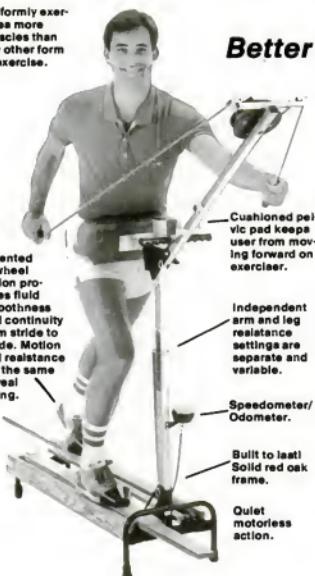
SUMMARY OF 1984 MERCEDES 190 OWNERS REPORTS*

Total miles driven	1,364,046	Styling	27.0	Front seats	71.8%	Average	8.3
Average miles per gallon		Comfort	26.1	Good	23.5	Poor	2.9
2.3-liter gasoline ohc Four		Performance	26.1	Average	3.8		
In town	23.1	Specific dislikes:		Poor	0.9		
On the highway	28.5	No complaints	14.4%	Front seats			
2.2-liter diesel ohc Four		Lacks overall roominess	11.3	Excellent			
In town	33.9	Not enough power	10.3	Good			
On the highway	40.6	Not enough rear legroom	7.7	Average			
Engine choices:		Weak air conditioner	5.7	Poor			
2.3-liter gasoline ohc		Poor radio	5.7				
Four	62.8%	What changes would you like?					
2.2-liter diesel ohc Four	37.2%	No changes	25.1%	Had any mechanical trouble?			
Transmission choices:		More horsepower	9.7	No	69.4%		
Four-speed automatic	68.4%	More rear legroom	7.7	Yes	30.6		
Five-speed manual	31.6	Offer tilt wheel	6.3				
Why did you choose this car?		Offer turbocharger	5.8	What type of trouble?			
Quality	26.1%	How much did you pay?		Air conditioner	23.6%		
Size	19.4	Average	\$23,851	Cruise control	12.5		
Styling	18.5	Range	\$21,000-\$27,000	Transmission	9.7		
Reputation	18.5	Workshop opinion:		Electrical	8.3		
Value (worth the price)	18.0	Excellent	80.9%	Sunroof mechanism	8.3		
Specific likes:		Good	17.4	Cam-cover leak	8.3		
Handling	60.8%	Average	1.3	Dealer repairs satisfactory?			
Economy	31.1	Poor	0.4	Yes	76.3%		
Riding qualities	27.9	Workshop opinion:		No	23.7		
Comfort opinion:		Dealer service opinion:					
Patented flywheel action provides fluid smoothness and continuity from stride to stride. Motion and resistance are the same as real skiing.		Excellent	48.5%	Yes	68.4%		
Cushioned pelvic pad keeps user from moving forward on exerciser.		Good	40.2	No	7.7		
Independent arm and leg resistance settings are separate and variable.				Maybe	23.9		
Speedometer/ Odometer.				Age distribution of owners:			
Built to last! Solid red oak frame.				Under 29 years	8.3%		
Quiet motors and action.				30-49 years	57.2		
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*Percentages might not equal 100% due to rounding or insufficient data.

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PM PHOTO HINTS

Film-soup fog



Particles that accumulate in film developer and turn it foggy are too small to be trapped by a filter funnel. They'll rarely interfere with development, but they can leave gummy deposits on negatives. Remove them by pouring chemicals through coffee filters.

—Kenn Oberrech

Penny-wise, gallon foolish



It's more economical to buy developers in gallons, but exposure to air can spoil the solution. Store the gallon in four one-quart bottles so that three remain closed and safe from oxidation.

—Bob Berger

Unhealthy air



Air is the enemy of photo developers. This picture shows what it can do, in time, if the bottle cap isn't closed tightly or if the inside gasket is worn.

—Robert Hertzberg

Good with your hands? Teach yourself to play!



The Korwin Learning System: Keyboard is a cassette-tape course that teaches you how to play piano and electronic keyboard.

It is designed for adults who never touched a keyboard before in their life, but "progresses in easy steps to become the most savvy and sophisticated keyboard advice ever offered to the public."

You don't have to know how to read music and the course doesn't teach it; you'll learn to play by ear!

WHAT YOU WILL LEARN

Practicing 15 minutes each day, here's what you'll be able to do:

- After the first lesson, you will be making up your own melodies and playing them with both hands.
- After the fourth lesson, you will be playing your favorite songs.
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- 10 lessons for piano and electronic keyboard on 6 cassette tapes.
- 85 page manual with over 100 large clear illustrations showing exactly what your hands should do.

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You will have 30 days to try the course. If it doesn't work for you, you may send it back for full refund of the purchase price.

Since this new method was introduced last fall, hundreds of people have proved to themselves that this course *does* work. They have achieved the ability to create music with their own two hands. . . . You can too!

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Price:
\$95 plus \$4 UPS shipping & handling.
Illinois residents add \$7.60 IL sales tax.

FORD'S AEROSTAR MINIVAN

(Continued from page 154)

wells. Ground-to-floor height is 20.3 in. Interior cargo volume of the van is 143.5 cu. ft., or up to 175.9 cu. ft. if the right-side passenger seat is removed. Compare that with the Chevy Astro/GMC Safari cargo capacity rating of 151.1 cu. ft. (with both front seats in place) and the Dodge Caravan/Plymouth Voyager volume of 125 cu. ft.

Although the Aerostar is an inch shorter than the Chrysler Corp. minivan, it is 3 in. wider and 8 in. higher. More important to users though, with the extra-cost V6 engine (an option not yet available in the Chrysler minis) the rear-drive Aerostar is rated to tow a 5,000-pound load. The front-drive Caravan/Voyager will only pull a 2,000-pound trailer.

Aerostar pricing isn't firm at this writing but the wagon should be competitive with the Chrysler T-wagons. Playing a part in this could be the start-up delays at the St. Louis assembly plant where Aerostar will be built. Heavily automated, the plant reportedly has had quality problems with new assembly hardware, primarily automated welding equipment and the software that operates it. Ford pegs late spring as the intro date, back a couple of months from first estimates. Insiders report sometime in May.

We think you're going to be seeing a lot of Ford's Aerostar in the future. I can already picture it as a bread 'n' butter truck—and Ford bean counters undoubtedly feel the same way. **PM**

THE PM REPORT CARD

FORD AEROSTAR	GRADE	COMMENTS
Acceleration	B+	Good with V6; fair with Four.
Handling	B	Wagon a bit soft; van good.
Braking	B+	Class-average; good pedal modulation.
Steering	C	No road feel, bus-driver tilt to wheel.
Transmission	A	Shifts smoothly.
Ride	A	Effective bump damping.
Fuel economy	NA	
Seating	A	Plush, and lots of it.
Vision	A/C	Excellent in wagon; marginal in van.
Gauges/controls	A	Analog is better; LCDs very Japanese.
Ventilation	A	Many outlets, good fan action.
Noise @ 55 mph	A/C	Wagon is quiet; van noisy.
Cargo capacity	B+	Decent room for family or cargo.
Engine serviceability	B+	Low hood.
Fit and finish	A	Good job!

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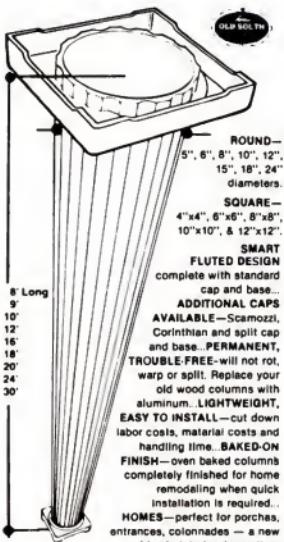
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HINTS FROM READERS

Self-cleaning litter picker

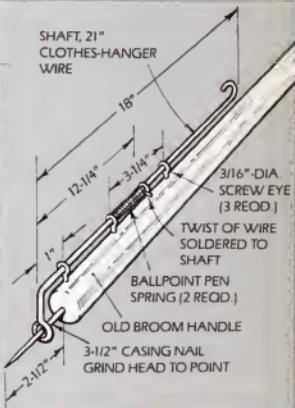
Tired of bending your back to pick up litter that encroaches on your domain? End the drudgery with this self-cleaning litter picker—a spiked tool that pierces the offending object, then you eject it into a trash receptacle without it being touched by human hand.

To make the litter picker, drive a $3\frac{1}{2}$ -in. casing nail 1 in. deep into the end of an old broom handle, and grind its head to a point. The self-cleaning mechanism is made from a straight length of clothes hanger wire, its front end bent into a right-angled loop to fit over the sharpened nail. Its opposite end passes through three small screw eyes positioned on the handle.

Before passing the shaft through the last screw eye, slip on two small coil springs—salvaged from old ballpoint pens—followed by a small twist of copper wire. Solder the twist of wire to the shaft. Finally, bend the upper end of the shaft into a loop to provide a thumb press.—Louis Hochman

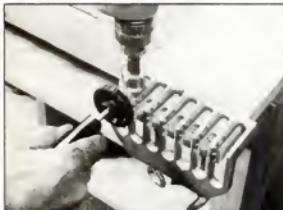


Litter picker saves bending. Push the looped end of the shaft to clear litter from spike.



PM LOOKS AT...

A dovetail jig



This drill-powered jig will cut half-blind dovetails in stock up to 1 in. thick. Hold the drill in a vertical position (top) to cut the sockets that accept the dovetails. The finished joint that is shown above took less than five minutes to complete.

Until now there have been two ways to make dovetail joints: by hand, using a saw and chisel; or with a router and a dovetail template. But now there's a third option—the Wolfcraft drill-powered dovetail jig.

This unique tool will allow you to produce half-blind dovetail joints using a $\frac{1}{4}$ - or $\frac{3}{8}$ -in. drill. The dovetailer (Model 4200) consists of a self-clamping template, cutter guide, auxiliary handle with depth stop, cutter holder and drill arbor, and $\frac{1}{4}$ -in. dovetail bit. In addition, straight bits are available for cutting box joints.

First, clamp the jig to the workpiece to rout the sockets that accept the tails. Chuck the arbor into the drill and slide the cutter holder into one of the channels in the jig, as shown. Then, start the drill and push the cutter into the work. Repeat this for each channel.

Next, cut the tails using the channels on the jig side. Since the tails are cut through the work, clamp a backup board to the workpiece to prevent splintering and to keep the cutter from hitting the jig.

The Wolfcraft dovetailer is \$30 at hardware stores and many mail-order tool firms. For details, contact Joe Karkosch, 1107 Lunt Ave., Schaumburg, Ill. 60193.—Rosario Capotosto

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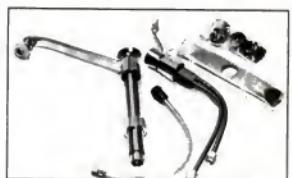
PM LOOKS AT...



A rising faucet

Moen introduces the Riser—the first adjustable-height faucet. Just lift the spout and the Riser locks into position 9 in. above the top of the sink. This permits filling tall vases, pitchers and oversize pots and pans.

The Riser is designed for easy do-it-yourself installation and comes with all the necessary tubing and connections. The spout is equipped with a water-saving aerator that sprays, aerates and swirls to reach every corner of the sink. The aerator limits water flow to 2.75 gal. per minute. The Riser comes in two sizes: kitchen (\$125) and lavatory (\$115). For details, contact Moen, 377 Woodland Ave., Elyria, Ohio 44036.—Rosario Capotosto



Faucet comes with all necessary tubing and connections. Features include washerless cartridge, single-lever water control.



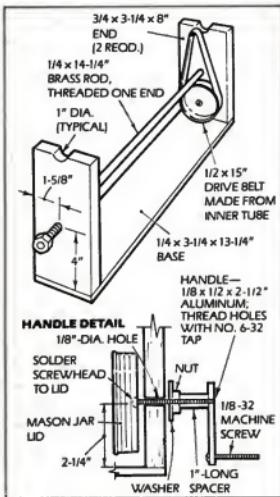
The new Riser lavatory faucet locks into position to permit washing hair easily.

HINTS FROM READERS

Fishing pole eye wrapper



End brackets support pole, which is turned by belt. Thread winds around shaft and eye from spool suspended below pole.



This hand-cranked eye wrapper ties eyes on fishing poles quickly and neatly, with thread supplied from a spool that slides freely on the brass rod directly under the pole. The pulley that spins the pole is a mayonnaise or mason jar lid with the head of a 1 1/2-in.-long brass screw soldered to its inside surface. The drive belt is cut from an old inner tube. Cut No. 6-32 threaded holes in each end of the crank arm, one for the axle screw, the other for the screw that serves as crank handle. Since the winder is turned clockwise, both screws will remain tight in the arm.—Louis Hochman

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The secret of Mantis' success is its exclusive "tine teeth" which spin at 240 revolutions per minute (twice the speed of most tillers). These *tine teeth* cut through soil, weeds and tough sod like a chain saw cuts through wood.



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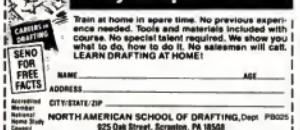
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POPULAR MECHANICS • MARCH 1985 185

PM'S TIME MACHINE

75 YEARS AGO: March 1910



Underwater escape announced.

Escape from subs

Submarine warfare at the beginning of World War I spurred a demand for rapid, safe escape from submerged disabled electric boats. A helmet connected to a waterproof jacket was devised to enable crewmen to avoid poisonous gases and provide enough oxygen for the ascent to the surface. The jacket contained an air purifier and an oxygen generator. This method was adequate until the age of deep-diving atomic subs. Now, in addition to the single-unit life jacket, deep-depth rescue vehicles are necessary.

Japan donates trees

The first lady, Mrs. William Howard Taft, thought Japanese cherry trees were extremely attractive. In response to Mrs. Taft's admiration, Japanese officials sent 2,000 cherry trees for planting along a 3-mile stretch of the Potomac. One group of botanists protested that the trees could not survive Washington's worst summers. But they took root and today remain the capital's major tourist attraction. Last year, a team of Japanese botanists visited Washington for a conference on cherry trees.



Lawn seeder

This new type of lawn seeder operated similarly to wheat and oat sowers. And it was good enough to last. Current lawn-treatment machines use the same basic seeding device.

50 YEARS AGO: March 1935

Prophetic visions

An optimistic look at visionaries such as Thomas Edison, Col. John Jacob Astor, Hudson Maxim and others indicated that what seemed farfetched 25 years ago would be commonplace. For example, in 1910, Edison predicted mail would travel by air at speeds up to 100 mph. And Irving Twombly predicted the automobile would "tend toward increased strength of materials, reduction in the weight and size of all moving parts." The artist's cover stylistically captured helicopters on roofs above metropolises.



Streamlined locomotive

New York Central boasted of having the only streamlined steam locomotive. Growing use of diesel and electric powered locomotives, however, would displace the 90-mph streamliner.

Crash fences

Highway engineers in Massachusetts found that the best way to test protective fences designed for curves and other hazardous road sections was to crash cars into them. Guard fence sections were erected at the bottom of a steep grade, and the cars were steered into the sections head on. Engineers are still crashing cars into walls and fences—but they're testing the cars rather than the obstruction. Guard rail and guard wall materials are tested in labs using equipment to duplicate crash conditions.

25 YEARS AGO: March 1960

It's a what?

It's a Kolumaran. And it was featured on our cover. It was designed and built by a San Diego aircraft engineer. It featured a three-hulled outrigger design and combined the speed, stability and shallow draft of multihulled crafts with the room and utility of a cruising boat. It had an 8 x 16-foot cabin with 6 feet of headroom. The multi-hull design stabilized the craft in 100-mph winds. Such vessels, called trimarans today, are built of aviation materials and have computer-operated sails for precision turning in wind.

Machine zips letters

Before the institution of ZIP codes, the Postal Service installed the world's largest letter-sorting machine at its Detroit post office. The machine handled 36,000 letters an hour. A letter placed on a scanning board was read by an operator who in turn pressed one of 12 destination keys. The letter was dropped into a conveyor system then into a routing bin. It's not hard to tell where the idea for ZIP codes originated. Today's machines sort mail 40 percent faster, and an extra four digits have been added to the ZIP code.



Missile-firing copter

The Army's newest tank killer was airborne. Double-sided missile racks attached to a helicopter were capable of disabling any armored vehicle. Killer choppers today are firing more sophisticated weapons.



Three-hulled ships launched.



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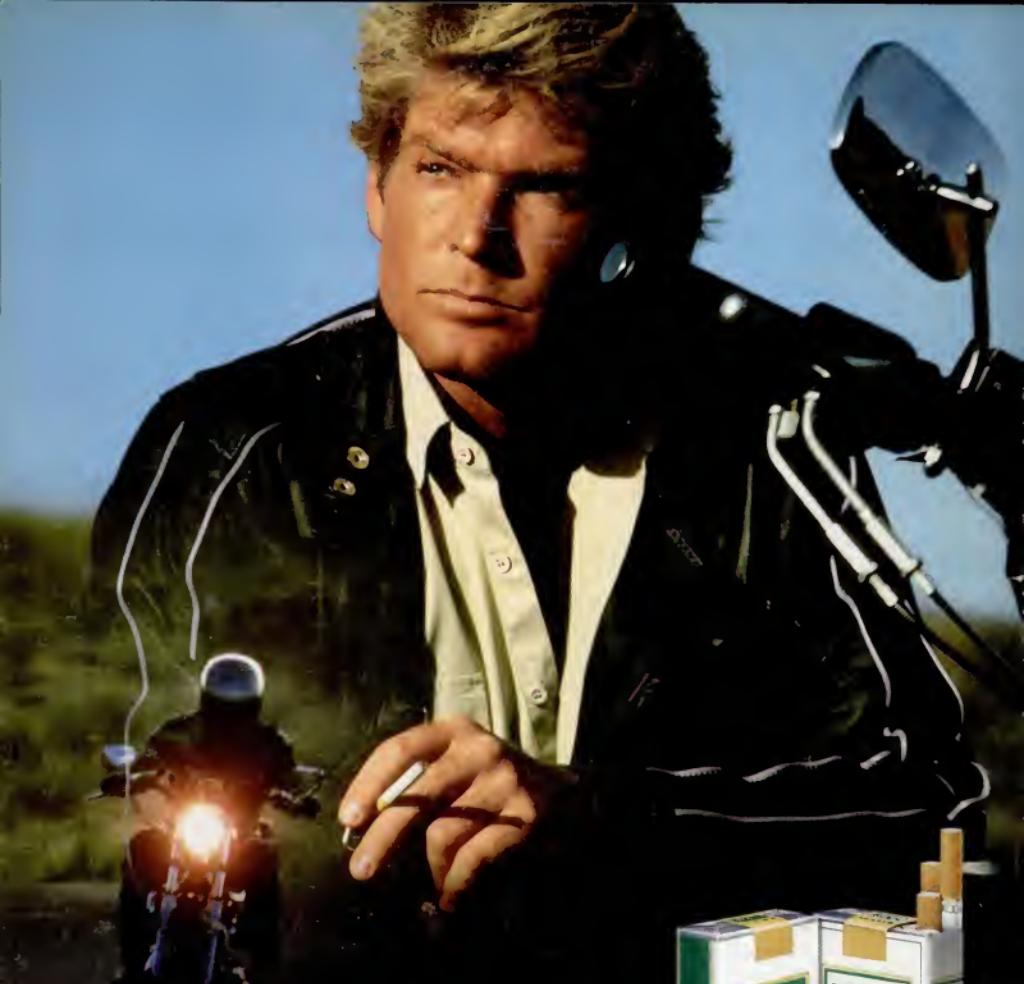
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